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JOURNAL OF DAIRY SCIENCE

A STUDY OF THE SEVERAL MINNESOTA REAGENTS FOR THE DETERMINATION OF FAT IN BUTTERMILK*

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INTRODUCTION

To date, three Minnesota reagents for the determination of fat in dairy products have been presented. For convenience the original reagent (4) will be designated, Reagent A, that described by Sommer (5), Reagent B and the one sold by the Kimble-Nafis Company (2) during the spring of 1935, Reagent C.

Dr. B. L. Herrington called the attention of the writers to the fact that results obtained with Reagent C did not conform with the results they had reported for Reagent A. The results with Reagent C were said to be much lower than those for Reagent A. Greater saponification with Reagent C than with Reagent A was suggested as the cause of the difference although the methods or data on which this suggestion was based were not disclosed.

The objectives of this study were, therefore, to determine the magnitude of the difference between the tests obtained by Reagents A and C, to determine to what extent this difference resulted from greater saponification by the latter reagent and to determine the general relationships existing among the results obtained by the three reagents.

METHODS AND RESULTS

1. The effect of different manipulative methods on the results obtained with Reagent C. The effect of the use of phenolphthalein in 95 per cent alcoholic solution and the use of two 0.5 minute as against a 5, 2 and 1 minute centrifuging procedure were checked. Nine gm. samples, 10 cc. of reagent and 5 minute digestion times at approximately 90° C. were used. The results are presented in Table 1. They indicate that the use of the standard centrifuging procedure with 95 per cent alcoholic phenolphthalein yielded the highest test. It was considered that the method yielding the

TABLE 1

Results obtained with Reagent C with different testing procedures on the same buttermilk sample. (Mojonnier test 0.574%)

TEST NUMBER	2-0.5 MIN. CENTRIFUGING PERIODS ; 2 CC. 1% PHENOLPHTHALEIN IN 95% ALCOHOL	2-0.5 MIN. CENTRIFUGING PERIODS ; NO PHENOLPHTHALEIN USED	5, 2 AND 1 MIN. CENTRIFUGING PERIODS ; 2 CC. 1% PHENOLPHTHALEIN IN 95% ALCOHOL	5, 2 AND 1 MIN. CENTRIFUGING PERIODS ; NO PHENOLPHTHALEIN USED
	Per cent	*Per cent*	*Per cent*	*Per cent*
1	0.10	0.06	0.22	0.16
2	0.10	0.06	0.22	0.16
3	0.10	0.07	0.22	0.16
4	0.09	0.06	0.23	0.16
Average	0.098	0.063	0.222	0.16

highest test would be the best one to use in the indirect method of determining saponification that will be described later.

2. A comparison of the results obtained with the three Minnesota reagents when 5, 2 and 1 minute centrifuging periods were employed. Here 9 gm. samples, 10 cc. reagent and a 6 to 7 minute digestion period at approximately 90° C. were used (4). The data are recorded in Table 2.

TABLE 2

Comparison of tests of the same buttermilk with Minnesota reagents A, B and C, with 5, 2, and 1 minute centrifuging periods. (Mojonnier test 0.574%)

TEST NUMBER	REAGENT A	REAGENT B	REAGENT C
	Per cent	*Per cent*	*Per cent*
1	0.36	0.30	0.22
2	0.38	0.31	0.22
3	0.42	0.29	0.23
4	0.38	0.30	0.22
5	0.39	0.26	0.27
6	0.40	0.28	0.26
7	0.41	0.28	0.26
8	0.44	0.28	0.24
9 . .	0.40	0.26	0.24
10	0.41	0.27	0.26
11	0.38	0.26	0.24
12	0.40	0.26	0.22
13 . .	0.41	0.24	0.21
14	0.41	0.24	0.20
15	0.41	0.24	0.19
Average	0.400	0.271	0.232

They indicate that when the procedure recommended originally for the Minnesota test is employed the fat test of the same buttermilk drops from Reagent A, to Reagent B, to Reagent C.

3. Methods employed to obtain data from which the degree of saponification with the three Minnesota reagents was estimated. For these runs 9 gm.

TABLE 3

Check on the saponification of butterfat in performing the Minnesota fat test in buttermilk with reagents A, B, and C.
(Mojonnier test 0.786%)

HEATING TIME IN MINUTES	REAGENT A Test	% of max.	REAGENT B Test	% of max.	REAGENT C; 95% ALCOHOL PHENOL PHTHALEIN 5, 2, 1 MIN. CENT. Test	% of max.	REAGENT C; AQUEOUS PHENOLPHTHALEIN 5, 2, 1 MIN. CENT. Test	% of max.	REAGENT C; 95% ALCOHOL PHENOLPHTHALEIN 2-½ MIN. CENT. Test	% of max.
0.0	0.03		0.03		0.02		0.01		0.01	
	0.02		0.04		0.03		0.01		0.01	
	0.03		0.07		0.03		0.02		0.02	
Average	0.027	4.91	0.047	8.86	0.027	5.59	0.013	4.06	0.013	4.48
2.0	0.22		0.37		0.40		0.21		0.12	
	0.14		0.37		0.32		0.21		0.12	
	0.22		0.43		0.28		0.21		0.14	
Average	0.193	35.10	0.390	7.36	0.333	68.85	0.210	65.60	0.127	43.80
5.0	0.58		0.53		0.47		0.32		0.23	
	0.54		0.53		0.49		0.32		0.24	
	0.53		0.53		0.49		0.32		0.28	
Average	0.550	100.00	0.530	100.00	0.483	100.00	0.320	100.00	0.250	86.20
10.0	0.53		0.47		0.37		0.28		0.31	
	0.54		0.47		0.35		0.28		0.32	
	0.54		0.49		0.30		0.29		0.24	
Average	0.537	97.60	0.483	91.10	0.340	70.40	0.283	88.41	0.290	100.00
15.0	0.54		0.46		0.26		0.18		0.18	
	0.52		0.44		0.26		0.20		0.06	
	0.54		0.44		0.26		0.20		0.20	
Average	0.533	96.90	0.447	84.30	0.260	53.93	0.193	60.32	0.147	50.70
25.0	0.49		0.36		0.16		0.16		0.13	
	0.46		0.33		0.17		0.15		0.15	
	0.48		broken		0.17		0.17		0.15	
Average	0.477	86.70	0.345	65.10	0.167	34.58	0.160	50.00	0.143	49.30
40.0	0.48		0.26		0.12		0.05		0.09	
	0.50		0.25		0.09		0.06		0.01	
	0.47		0.24		0.00		0.06		0.12	
Average	0.483	87.50	0.250	47.15	0.070	14.49	0.056	17.48	0.073	25.16
60.0	0.51		0.18		0.15		0.06		0.13	
	0.54		0.17		0.14		0.06		0.12	
	0.54		0.20		0.00		0.06		0.16	
Average	0.530	96.40	0.183	34.52	0.097	20.08	0.060	18.75	0.137	47.25

samples, 10 cc. of reagent and a bath temperature of approximately 90° C.
were employed. Three manipulative methods were employed with Reagent
C. These are given in Table 3. The aqueous phenolphthalein was prepared
by dissolving the indicator in N/10 NaOH. The digestion of the samples
was carried out for various lengths of time, and except where otherwise
stated, 5, 2 and 1 minute centrifuging periods were employed. One large,
well-mixed buttermilk sample was used for all the tests. The data are
presented in Table 3.

4. It was considered desirable to obtain data comparing tests with the
three Minnesota reagents, the American Association, the Babcock and the
Mojonnier testing methods. These data were again obtained with one large,
well-mixed buttermilk sample. The methods employed for all but the tests
with Reagent C have been previously described (1). In determining the
fat percentage with Reagent C, 9 gm. samples, 10 cc. of reagent, 2 cc. of
1 per cent phenolphthalein in 95 per cent alcohol, 5 minute digestion periods
at approximately 90° C. and two 0.5 minute centrifuging periods were used
(3). The data are presented in Table 4.

TABLE 4

*Comparison of tests of the same buttermilk with Minnesota reagents A, B, and C, the
Babcock and the American Association methods. (Mojonnier test 0.745%)*

TEST NUMBER	MINNESOTA REAGENT A	MINNESOTA REAGENT B	MINNESOTA REAGENT C	AMERICAN ASSOCIATION	BABCOCK
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1	0.54	0.50	0.26	0.74	0.30
2	0.52	0.40	0.23	0.70	0.20
3	0.52	0.46	0.16	0.78	0.24
4	0.48	0.46	0.16	0.72	0.17
5	0.53	0.47	0.16	0.72	0.25
6	0.49	0.49	0.21	0.74	0.17
7	0.52	0.47	0.17	0.76	0.22
8	0.50	0.48	0.19	0.72	0.30
9	0.55	0.44	0.16	0.76	0.21
10	0.51	0.47	0.18	0.72	0.27
11	0.51	0.46	0.26	0.76	0.27
12	0.47	0.48	0.24	0.75	0.20
Average	0.512	0.465	0.198	0.739	0.233

DISCUSSION OF RESULTS

The data of Table 1 show that when 5, 2 and 1 minute centrifuging
periods were used with Reagent C, the resulting tests were higher than with
the other methods, providing a 1 per cent phenolphthalein solution in 95
per cent alcohol was used. For this reason, and because of the fact that
this centrifuging procedure is like that for Reagents A and B, it was
adopted for the study of the amount of saponification that occurs during
the digestion of the samples.

It is evident from Table 2 that when this centrifuging method is employed with all three reagents the results obtained vary considerably and become progressively lower from Reagent A, to Reagent B, to Reagent C.

Fig. 1 presents the averages of the triplicate tests for Reagents A, B and C (alcoholic phenolphthalein) of Table 3. plotted against digestion time. Graphs were drawn through the points representing each reagent. These
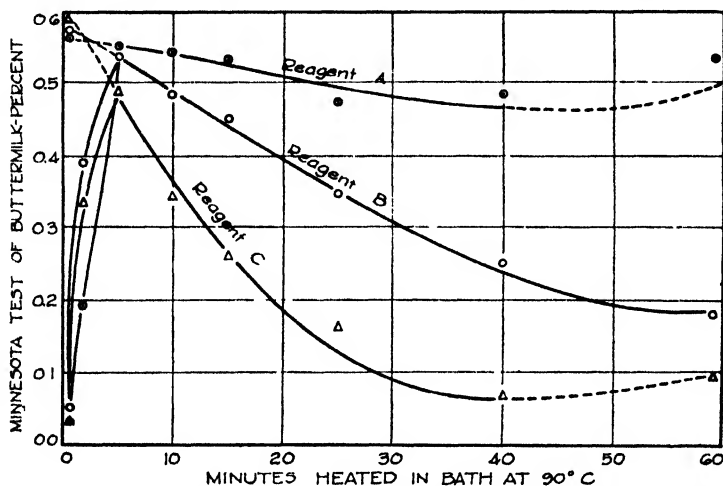
FIG. 1. The relationship between the digestion time and fat test with Minnesota reagents A, B and C.

rose steeply to maxima at approximately five minutes digestion time. As the time lengthened the curves dropped off; that for Reagent A, least, that for Reagent C, most and that for Reagent B, at an intermediate rate. The portions of the curves to the right of the maxima were extrapolated to zero time. This value it was considered should have given the maximum tests that it would have been possible to have obtained with these reagents had no saponification occurred.

The method may be criticized because of the fact that the values obtained by extrapolation of these curves may not be as precise as might be desired. Considering that Reagent C contains "castor oil potassium hydroxide soap solution" (2) the usual methods of acidification and extraction could not be carried out. The method employed seemed to be the logical one for determining the amounts of saponification under these conditions. The extrapolated values obtained for the three reagents were:

Reagent A .. .	0.566 per cent
Reagent B	0.576 " "
Reagent C	0.598 " "
Average	0.580 per cent

These values fall surprisingly closely together considering the crudeness of the method employed.

If the assumption is made that the average of the above values (0.580 per cent) is the value that would have been obtained had no saponification occurred, the percentages of saponification if the tests were maximum are:

	VALUE OF MAX. TEST	0.580—MAX. TEST	% TEST LOWERED BY SAPONIFICATION
Reagent A	0.550	0.030	5.17
Reagent B	0.530	0.050	8.62
Reagent C	0.483	0.097	16.73

If the additional assumption be made, that the rate of saponification is the same for Table 4 as it was with Reagent A for Table 3, then the Table 4 reading corrected for saponification, the difference between this reading and that for Reagent C with two 0.5 minute centrifuging periods and the percentages of the corrected reading equivalent to this difference, the difference caused by saponification and the difference resulting from different manipulations of the tests are:

Data from table 4

TEST AS READ REAGENT A	TEST CORR. FOR SAPON- IFICATION REAGENT A	TEST AS READ REAGENT C	TOTAL DIFF. AS % CORR. TEST REAGENT A	% CORR. TEST (A) LOWERED BECAUSE OF SAPONIFI- CATION	% CORR. TEST (A) LOWERED BY DIFF. IN MANIPULATION OF TEST
0.512	0.534	0.198	62.23	16.73	45.50

When the following data from Tables 1 and 2 are employed: a. Reagent C, 5, 2 and 1 minute centrifuging periods = 0.232 per cent, b. Reagent C, two 0.5 minute centrifuging periods = 0.098 per cent and, c. test with Reagent A corrected for saponification = 0.422 per cent, the percentages of the corrected Reagent A test equivalent to; d. the total difference (c–b), e. that resulting from manipulative difference (a–b) and f. that resulting from saponification (d–e) are respectively 45.02, 31.72 and 13.30 per cent.

At first glance these two sets of results (calculated from Table 4 and from Tables 1 and 2) seem to present considerable variation. If, however, the percentages of the total difference between the corrected Reagent A and the two, 0.5 minute centrifuged Reagent C readings, that is caused by saponification and by the manipulation of the test are calculated, it is found that very close agreement exists between the two sets of data:

DATA FROM	PERCENTAGE TOTAL DIFF. ◇ SAPONI- FICATION	PERCENTAGE TOTAL DIFF. ◇ MANIPU- LATION
Table 4	26.89	73.11
Tables 1 and 2	29.33	70.47

The data of Table 4 indicate that the values for buttermilk fat content obtained with the commercial reagent (C), used as directed (3), with two 0.5 minute centrifuging periods yield results that approximate very closely the regular Babcock method for buttermilk testing.

The last two columns of Table 3 indicate that the alcohol present in a 1 per cent solution of phenolphthalein in 95 per cent alcohol increases the saponification rate after the maximum test is reached, that it lowers the maximum test obtained and that it retards the attainment of the maximum test from the 5 minute to the 10 minute digestion point.

SUMMARY AND CONCLUSIONS

1. Different values for the fat content of buttermilk are obtained with each of the three Minnesota reagents that have been proposed, when the same sample of buttermilk is tested.

2. The commercial reagent (C) yields a test slightly lower than that obtained by the regular Babcock test, when Reagent C is used in accordance with the directions furnished with the reagent.

3. Saponification was shown to occur with all three reagents. The amount of saponification for these reagents was estimated as follows: Reagent A, 5.17 per cent, Reagent B, 8.62 per cent and Reagent C, 16.73 per cent.

4. Approximately 70.0 per cent of the difference between the reading with Reagent A (corrected for saponification) and that of Reagent C is the result of differences in manipulative procedure; the other 30 per cent is caused by saponification.

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VARIATIONS IN THE VITAMIN C CONTENT OF MILK*

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INTRODUCTION

In previous publications (1, 2) attention has been called to the fact that the chemically determinable vitamin C content of milk may vary greatly from day to day, and between individual cows. It has also been found (3) that under suitable conditions milk may be kept 24 hours or more without serious loss of vitamin C.

In the fall of 1935 a series of tests was started, on individual cows from the station dairy herd, to determine variations in the vitamin C content of milk. These tests were designed to find differences due to the hour, day, and season when the test was made; and also variations due to the breed, individuality, milk yield, age, and stage of lactation of the cow. Other workers (4) have discussed some of these factors, and some of their findings differ from those of this station.

PROCEDURE

Forty cows about equally distributed among the Ayrshire, Guernsey, Holstein, and Jersey breeds were tested 3 consecutive mornings in October and again in November. Sixteen of these cows were also tested both morning and evening for 7 days. Subsequent tests included all 55 to 58 cows of the station herd, distributed about equally among the four breeds. In these tests 10 ml. of milk stood 30 minutes with 15 ml. of 10 per cent trichloracetic acid. Five ml. of the resulting serum was titrated with 2–6-dichlorophenol-indophenol (4, 5). Except as noted below all cows were fed, according to production, a ration consisting of alfalfa hay, atlas sorgo silage, and a grain mixture. No pasture was available to these cows.

As a part of a study of vitamin C metabolism, which will be reported in detail elsewhere, 3 cows were fed after the April tests as much green rye as they would consume. By the end of one week they were each consuming approximately 65 Kg. per day of rye that tested 0.86 mg. of vitamin C per gram. This would be equivalent in vitamin C content to 30 gallons of orange juice per cow per day. The vitamin C contents of the milk and urine were determined at suitable intervals. Milk samples from 3 other cows previously found to give milk of comparable vitamin C content and constancy were also tested at the same milkings as the test animals.

<div align="center">RESULTS</div>

It was soon recognized that any value for vitamin C is influenced by several factors. In October, 107 comparisons on cows milked at 12-hour intervals indicated that evening milk contains 2.0 ± 0.7 mg. per liter more vitamin C than morning milk, with less than 1 chance per million that the difference was all accidental. This difference may be helpful in finally locating the mechanism by which vitamin C secretion is controlled. It also indicates the necessity for making comparative tests at the same time of day.

Each monthly test provided 2 consecutive comparisons of daily changes. Daily changes in the average value of the herd are shown in Table 1.

<div align="center">TABLE 1
Daily change of vitamin C in herd milk</div>

Day	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.
	Change in vitman C content, mg. per liter						
1st.–2d.	+ 4.5	+ 0.3	− 4.4	+ 6.1	+ 3.1	+ 3.2	+ 2.2
2d.–3d.	− 5.8	+ 2.4	+ 1.2	+ 0.6	− 0.1	+ 0.5	− 1.7

These variations are large enough to indicate that the vitamin C content of milk from a given cow or herd can not be adequately determined by a single test.

Thirty-six cows beyond the second month of lactation were tested both in December and in February. The coefficient of correlation between these tests was .89. The corresponding correlation between values in February and March was .66. The 6 correlations calculated ranged from .66 to .94. These values are high and justify the conclusion that comparisons between individuals or groups, at the same time, are more reliable than the single values compared, or than comparisons of values determined at different times.

The simplest measure of the effect of season is the herd average for each month.As will be shown later, the early stages of lactation coincide with a low vitamin C content. The average for the herd excluding cows in the first and second months of lactation was therefore calculated. Both these sets of values and the ratio of each value to that for the preceding month are shown in Table 2.

<div align="center">TABLE 2
Monthly average vitamin C content of milk from whole herd and herd excluding fresh cows</div>

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.
	Whole Herd						
No. cows	40	40	58	57	55	55	58
C mg./liter	23.6	27.2	29.2	23.8	22.2	26.0	24.5
Ratio to previous month		1.14	1.07	.81	.94	1.17	.94
	Herd with 1st and 2nd months lactation excluded						
No. cows	34	35	47	48	47	43	47
C mg./liter	23.6	27.0	29.7	24.2	22.8	26.4	25.8
Ratio to previous month		1.14	1.10	.81	.94	1.16	.96

The effect of excluding cows in the first 2 months of lactation is small. This is the largest known secondary factor which was not held constant during the comparison of different seasons. It seems reasonable therefore to conclude that the changes for the reduced herd are related to seasonal changes. The average vitamin C content of milk from all cows and for all months tested was 25.5 mg. per liter.

The low values in January and February coincide with the season of continued wintry weather. For these months the cows were stabled most of the time. The temperatures in the barn approximated the out-door temperatures to which the cows were exposed in December and March. The humidity in the barn was higher. The cows of course received less exercise and sunshine when stabled. Since the causes of the seasonal changes in vitamin C are obscure, it is impossible to predict when similar changes will be found again. Statistical analysis indicates, however, that there is less than 1 chance per million that the rise from October to December, the fall from December to February, or the rise from February to March is accidental.

For the 3 cows fed green rye, during some 12-hour interval within 60 hours after rye was first fed, the output of vitamin C in urine compared to the average of 2 similar intervals just before feeding rye increased 7.0, 5.1, and 4.5 fold respectively for the 3 cows. This included increases in concentration of 4.3, 1.6, and 2.0 fold respectively. The effect of green rye feeding on vitamin C content of milk is summarized in Table 3.

TABLE 3

Vitamin C in milk before and after feeding green rye

VITAMIN C EXPRESSED AS PER CENT OF CONTROLS

Milkings	Cinderella	Gaiety	Trixie
1–4 before	99	107	108
2–5 after	108	107	107
11–16 after	118	108	106
30	101	90	106

An increased output of vitamin C in urine is recognized evidence that the body reserves of the cows were normal. Whether or not the observed small increase in the milk of the first cow was significant cannot be stated. In the case of the other 2 cows, the increased intake of vitamin C was unquestionably accompanied by an increased excretion in the urine but no increased secretion in the milk. Fifteen days after the initial heavy rye feeding there was no significant increase in the vitamin C concentration of the milk from any of the 3 cows.

If cows beyond the second month of lactation were grouped by breeds, Jerseys were highest in vitamin C content in all months. No other breed held a constant rank. The average values were: Ayrshires 24.1, Guernseys 26.0, Holsteins 23.5, and Jerseys 29.2 milligrams per liter. There is no doubt but the higher values for this particular Jersey herd are significant. How-

ever, one day when this Jersey herd averaged 33.5 and the whole station herd averaged 28.5, another Jersey herd of 10 individuals located near the station and receiving a somewhat similar ration averaged only 24.4. In the station herd the average for Jerseys was 1.24 times that for Holsteins. Of the 8 Jerseys whose milk was richest in vitamin C, 6 were genetically related. The number of animals involved is too small to justify conclusions regarding heredity as a factor in vitamin C production. The genetic relationship between the high cows of this herd, together with the low value recorded for the

TABLE 4

Vitamin C in milk as ratio to previous month: actual (A), and relative to herd with 1st two months excluded (R), for numbers of cows (N)

STAGE OF LACT.		NOV.	DEC.	JAN.	FEB.	MAR.	APR.	AVE. R	TOTAL N
	A	1.29	1.29	.91	.97	1.59	1.02		
2/1	N	4	1	4	5	3	9		26
	R	1.13	1.15	1.12	1.03	1.37	1.06	1.10	
	A	1.30	1.08	.84	.94	1.32	.89		
3/2	N	2	4	6	4	2	3		21
	R	1.14	.98	1.04	1.00	1.14	.92	1.02	
	A	1.19	1.12	.82	.84	1.33	.92		
4/3	N	1	2	7	6	4	2		22
	R	1.05	1.02	1.01	1.00	1.15	.96	1.03	
	A		1.11	.79	.96	1.20	.89		
5/4	N		10	4	7	5	4		30
	R		1.01	.98	1.02	1.03	.93	1.00	
	A	1.19		.84	.88	1.14	.92		
6/5	N	1		11	4	5	5		26
	R	1.05		1.03	.93	.98	.96	.99	
	A	1.11	1.04		.91	1.28	.90		
7/6	N	9	1		11	4	6		31
	R	.98	.96		.97	1.10	.94	.98	
	A	1.12	1.08	.74		1.19	.90		
8/7	N	3	9	1		11	4		28
	R	.98	.98	.91		1.02	.94	.99	
	A	1.05	1.12	.80	.92		.96		
9/8	N	3	3	9	1		11		27
	R	.92	1.02	.99	.98		1.00	.99	
	A	1.21	1.11	.83	.95	1.25			
10/9	N	2	3	3	8	1			17
	R	1.06	1.01	1.02	1.01	1.08		1.02	
	A	1.13	1.01	.72	1.00	1.22	.78		
11/10	N	1	2	1	2	6	1		13
	R	.99	.92	.89	1.06	1.05	.81	1.00	

second herd mentioned above does, however, cast some doubt on the generally high values for Jerseys indicated by this herd.

The ratios of high to low vitamin C producing cows in each breed, averaged for 7 months, were: Ayrshires 1.54, Guernseys 1.27, Holsteins 1.41, and Jerseys 1.48. The smallest ratio between individuals within a breed was larger than the largest ratio found between breeds.

There appears to be no simple relation between vitamin C content and yield of milk. This conclusion is based both on comparisons of average values and also on comparisons of changes from day to day. An apparent decided trend in comparisons made 1 month may be reversed 1 or 2 months later.

The relation of vitamin C content of milk to the age of the cow is similar to that which has been established for fat content. It is small and unimportant.

To make use of a sufficient number of cows from the station herd for a valid statistical study of the effect of stage of lactation on the vitamin C content of milk, comparisons must include more than 1 month's test. Therefore, the effect of season as well as the effect of the individual cow, as a producer of milk of high or low vitaman C content, must be eliminated. The individuality factor can be eliminated by comparing changes in vitamin C content rather than actual content. The effect of season can be approximately eliminated by comparing changes in cows at a particular stage of lactation with average changes in the whole herd. This approximation can be improved by eliminating from the average for the herd, cows in those stages of lactation where most change was thus indicated. Actual ratios of values for successive months, and also the relative ratios obtained by dividing each actual ratio by the actual ratio for all cows beyond the second month of lactation, are shown in Table 4.

The data in the "average" column in Table 4 indicate that cows in the first month of lactation produce milk with about 10 per cent lower vitamin C content than in later months. Later stages of lactation do not influence the vitamin C content of milk.

CONCLUSIONS

The season of the year, the individuality and breed of the cow, and the stage of lactation appear to be the most important factors causing variations in the vitamin C content of fresh milk from well fed cows.

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A STUDY OF THE CHURN CLEANING METHODS USED BY PLANTS PRODUCING BUTTER OF VARIOUS YEAST AND MOLD COUNTS[1]

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The yeast and mold count of butter is commonly considered to give some indication of the sanitary efficiency of a creamery. A high yeast and mold count may be due to a number of factors; such as, inefficient pasteurization of the cream, contaminated butter cultures, infected churns, impure wash-water, a low salt content in the butter, careless handling of the butter after churning, infected wrappers and containers, and others. Practical experience as well as scientific investigations, however, have indicated that the improper care of the churn is one of the principal causes of high yeast and mold counts, because the churn being generally constructed of wood, is difficult to sterilize, especially if the rollers, shelves, or other parts of the churn have developed crevices and if organic matter has been allowed to accumulate in these as they most certainly will.

Since yeast and mold counts have been made regularly for nearly three years on all butter samples entered in the educational scorings conducted monthly by the State College of Washington, it was decided to examine the churn cleaning methods employed by the participating creameries and to study the extent to which these methods are reflected in the yeast and mold counts and perhaps the scores of the resulting butter. Consistently low yeast and mold counts should indicate satisfactory methods of caring for the churns.

REVIEW OF LITERATURE

That the churn is one of the greatest sources of contamination of butter made from pasteurized cream has been shown early by many investigators. Lund (1) found that high yeast counts were caused nine out of ten times by infected churns. Macy and Combs (2) discovered that the churn was the source of molds in 65 per cent of the creameries studied, salt in 33 per cent, the starter in 40 per cent, the water in 44 per cent and pipes and pumps in nearly 75 per cent of the creameries. Mold spores were carried by 90 per cent of the dry parchment and cloth circles examined. Macy, Coulter and Combs (3) found the churn to be the most prolific of all sources of yeast and mold infection. They frequently found a higher yeast and mold count in the butter than in the cream and the buttermilk.

The difficulty of eliminating yeasts and molds from the churn is explained by such findings as those of Macy, Combs and Morrison (4) who established the presence of molds in the joints between the churn staves at a depth of ¾–1 inch. Libbert (5) found that yeasts and molds will grow well even on churn wood alone.

Various procedures for cleaning and sterilizing the churn have been advocated. Hunziker (6) recommends as a daily treatment for churns to rinse with 50 gallons of hot water containing some suitable alkali, to drain the churn and then revolve it for at least 30 minutes with workers in gear while at least one quarter full of water at 200° F. or over. The churn should then be drained thoroughly and left to dry with the doors up and open. Before use on the next day the churn should be rinsed with cold water. He says that chemical disinfectants seem to be incapable of penetrating the wood adequately.

Other investigators including Gregory (7), Lund (8), Hood and White (9), Zakariasen (10) have shown the necessity of using a large volume of water at a high temperature for a sufficient length of time together with some alkali to keep the churn in a sweet sanitary condition. Occasional liming of the churn is often recommended to destroy yeast and molds effectively. Hood and White (9) advise the liming method of Lund and state that liming tends to harden the wood of the churn. Gregory (7) recommends rinsing the churn just before use with a chlorine germicide or washing again with water at 180–190° F. for 5 minutes and then rinsing with cold water.

Other investigators such as Shutt (11), James (12) and Olson and Hammer (13) obtained favorable results using chemical sterilizer solutions, especially when preceded by a satisfactory hot water treatment. James (12), however, found the evidence of the effectiveness of chemical sterilizers inconclusive and recommends the hot water treatment with ample periods of exposure and using enough water to cover the rollers and emphasizing the importance of working the rollers in the washwater to kill the organisms released by the strain of working on the churn parts. Morrison, Macy and Combs (14) found all chlorine sterilizers including sodium hypochlorite, alkaline crystalline hypochlorite, and chloramine T ineffective when used as the sole treatment. They demonstrated that the surface molds were destroyed by filling the churn one-third full with water at 96° C. (205° F.) and revolving one-half hour, but that the heat did not penetrate sufficiently to destroy molds underneath the surface of the wood. These authors considered alkaline washing solutions undesirable because of their softening effect on the wood and the use of steam was not recommended because of the blistering of the churn paint. They concluded that the most satisfactory treatment was the use of high temperature water for a sufficient period of time and repeated daily. Olson and Hammer (13) after an extensive investigation, however,

concluded that the deleterious effect of heat, alkali and chlorine compounds on the wood of churns should not be used as an argument against the proper treatment of churns, because in carelessly treated churns there will be serious deterioration of the wood due to the direct action of microorganisms. They found that churns contain comparatively small numbers of organisms, if rinsed well with 100–120° F. water, then washed carefully with ample amounts of water at 170–180° F. containing one pound of soda ash per 100 gallons, and finally revolved for 15–20 minutes while ½ full of water at 180–210° F. The use once a week of one pound of slaked lime per 100 gallons of the final rinse water was recommended. Following the above hot water treatment of 600 pound churns by a rinse with 10 gallons of sodium hypochlorite, chlorinated lime, or calcium hypochlorite in concentrations of 50–120 p.p.m. available chlorine at temperatures of 70–140° F. and revolving the churns containing these solutions for 5–45 minutes, caused still further reductions in the number of organisms in the churns. Treatment of the churn with cold saturated sodium chloride solutions after the regular hot water treatment did not significantly affect the number of organisms present.

Olson and Hammer (13) also showed that highly contaminated churns lowered the keeping quality of the butter when the butter was unsalted and was held at 32° or 45° F. The effect was insignificant when the butter contained 2.5 per cent salt. To what extent this effect of unclean churns on the quality of the salted butter is due to the direct action of yeasts and molds is still questionable

Macy and Richie (15) found that with fresh butter there was no consistent and direct relationship between yeast and mold count and the score of the butter They found a tendency, however, toward improved keeping quality for samples of low yeast and mold count, even though individual counts were no reliable indices of keeping quality. Interesting, although indirect, relationships have been pointed out by other investigators. Shutt (16) reports a considerably lower keeping quality for butter high in yeasts and molds than for butter of low counts when stored for six months at 10° F. Parfitt (17) noticed a tendency toward lower scores with higher yeast and mold, and especially yeast counts. Thomsen (18) found a definite trend toward reduced keeping quality with increasing yeast and mold counts. Ause and Macy (19) concluded that *Oospora lactis* utilizes or destroys the substances responsible for the pleasing starter flavor and aroma in butter.

PROCEDURE

Seventeen of the Washington plant operators participating in the monthly educational butter scorings reported the methods used by them in caring for their churns. Two one-pound butter samples from these plants had been received at 14–28 scorings and had been examined each time for yeasts and molds. All yeast and mold counts were made by plating 1 cc.

of a 1 : 10 dilution of the carefully sampled butter on Bacto Dehydrated Malt Agar adjusted to a pH of 3.5 and incubating at 21° C. (70° F.) for 5 days. The methods recommended by the American Dairy Science Association Committee on Bacteriological Methods (20) were followed in the procedure.   The butter was scored by four competent judges when fresh and after one month in storage at 36–40° F.   The identity of the samples was not known to the analysts and the judges.

For each of the above seventeen plants the median yeast and mold count of all samples submitted up to the time they reported their churn cleaning methods were calculated, and the distribution of high and low counts was studied.

RESULTS

Table 1 shows the ranking of the plants according to the median yeast and mold count of their butter entries.

TABLE 1

Yeast and mold counts of butter from plants reporting their churn cleaning methods

NO. OF CREAMERY	NUMBER OF SAMPLES ENTERED	MEDIAN YEAST AND MOLD COUNT PER ML.	% OF SAMPLES WITH YEAST AND MOLD COUNTS PER ML. OF				AVERAGE % SALT IN BUTTER
			1–50	51–100	101–1000	over 1000	
23	28	17.5	67.9	3.6	25.0	3.6	2.27
24	15	20.0	73.3	6.7	13.3	6.7	2.08
11	20	22.5	90.0	5.0	5.0	0	2.55
14	28	30.0	78.6	10.7	3.6	7.1	2.29
4	20	35.0	65.0	30.0	5.0	0	2.82
19	24	40.0	62.5	21.5	20.8	4.2	2.36
21	27	40.0	51.9	22.2	25.9	0	2.48
5	20	72.5	50.0	5.0	25.0	20.0	2.13
3	23	80.0	39.1	26.1	21.7	13.0	2.06
13	18	90.0	44.4	5.6	33.3	16.7	2.29
20	19	90.0	26.3	31.6	42.1	0	2.28
16	20	95.0	35.0	25.0	40.0	0	2.20
1	27	110.0	5.9	41.2	52.9	0	2.06
18	22	215.0	22.7	13.6	27.3	36.4	1.96
22	16	287.5	12.5	18.8	56.3	12.5	2.46
12	14	377.5	14.3	14.3	57.1	14.3	1.98
9	15	445.0	0	20.0	53.3	26.7	2.31

It will be seen that rather outstanding results were obtained by the first seven plants on the list.   The median count of these plants for 15–28 months was below 50, and over 70 per cent of the entries of each of these plants showed counts of 100 or less.

In the case of three of these plants over 70 per cent of the entries had yeast and mold counts of 50 or less, and for the other four plants over 50 per cent of the entries showed counts of 50 or less.   Although plant No. 23 ranked

highest in the median yeast and mold counts produced, plant No. 11 shows a
fine record because it produced counts of 50 or less on 90 per cent of its
samples. Its maximum count was 130, indicating very efficient care and
consistent results. Plants No. 4 and No. 21 also had no counts exceeding
1000, their highest counts being 110 and 290 respectively. The performance
of these seven plants appears to be distinctly superior to that of the other
ten plants.

Because low counts can never be obtained without scrupulous care of the
churn, the methods used by these plants must be considered and they are
given by the operators as follows:

Creamery No. 23

Rinse with water at 120–130° F.

Wash with 150 gals. of water above 150° F. containing 1½–2 lbs. washing
powder, revolving churn in high gear for 15 minutes.

Drain.

Leave doors up and open.

Before next use: Rinse with 100 gals. of cold water.

Creamery No. 24

Rinse with 75 gals. of water at 120° F., revolving churn 5 min.

Drain.

Wash with 150 gals. of water at 170° F. containing 2 lbs. of strained
hydrated lime, revolving churn in high gear for 15–20 minutes.

Drain.

Rinse with 75–100 gals. of water as hot as possible (190° F.) revolving
churn 5 minutes.

Drain.

Dry with doors up.

Creamery No. 11

Wash with 70–80 gals. of water at 120° F. containing 1 pound alkaline
crystalline hypochlorite, revolving churn in high gear 5–6 minutes.

Slush out by revolving churn with doors off.

Drain.

Slush out with 80–90 gals. of water at 180–190° F. revolving churn 5–6
minutes.

Drain. Leave doors off with opening up.

Before next use: Rinse with 60–70 gals. water containing one-fourth of a
pound of alkaline crystalline hypochlorite.

Creamery No. 14

Wash with lots of very hot water—no washing powder.

Drain.

Leave doors open and up.

Wash once a week with lime solution.

Creamery No. 4

Wash with 100 gals. of water at 100–120° F.   (Alkaline crystalline hypochlorite added once a week.)

Wash with 75 gals of water at 180–200° F.

Drain.

Leave doors up and open.

Before next use: Rinse with cold water.

Creamery No. 19

Rinse with water at 170–180° F.

Wash with 150–160 gals. of very hot water in high gear for 20 minutes. Every two weeks add 4 pounds of alkaline crystalline hypochlorite.

Drain.

Doors down 10 minutes, then up.

Creamery No. 21

When churn is used daily:

Wash with 200 gals. of water at 125–140° F. running the churn 5 minutes in low gear and 10 minutes in high gear.

Wash with 200 gals. of water at 190–200° F. running the churn 5 minutes in low gear and 10 minutes in high gear.

When churn is not used daily:

Wash with 200 gals. of water at 135–140° F. running the churn 5 minutes in low gear and 10 minutes in high gear.

Wash with 200 gals. of water at 190–200° F. containing 1½ lb. dehydrated lime, running the churn 5 minutes in low gear and 10 minutes in high gear.

In either case:

Empty the churn by revolving in high gear.

Drain 10 minutes with doors down.

Leave with doors up, covered with a screen.

In looking over the methods used by these plants, it becomes apparent that either very hot water of a temperature of 190–200° F. or large amounts of hot water and alkali, or hot water and a chemical sterilizer were used in washing the churn.   Such treatments will leave the churn dry and sweet.   It is interesting to note that plant No. 11, which is a plant receiving a poor quality cream, and which in spite of that had the highest percentage of low yeast and mold counts, is the only plant in the group using a **chemical sterilizer** in the rinse water applied just previous to churning.   Such a treatment or rewashing with very hot water was found necessary to secure low counts by Gregory (7).   Most plants used **alkali** in some form in the washwater.   Liming, at least occasionally, is practiced by some of these plants.   The rather low temperature of 150° F. used by plant No. 23 is no doubt compensated for by the large amounts of water and the addition of about 0.15 per cent alkali.

As seen from table 1, the butter made by plants 4 and 11 is slightly higher

in salt content than that of the other plants. This slightly higher salt in brine concentration, however, would not be expected to decrease the yeast and mold counts materially during the time interval between manufacture and analysis of the butter. This was shown by Macy (21) who found that there was no greater tendency for the more highly salted butter samples to decrease in yeast and mold count than for those of a lower salt concentration, after the butter had been in storage a week at 30–45° F. and in transit for a week at 42–67° F. Similar results were obtained by Macy, Coulter and Combs (3). Thus the slightly higher salt concentration in the butter of plants 4 and 11 would not be sufficient to produce the low yeast and mold counts, if the butter had been heavily contaminated from the churn.

While low counts must indicate satisfactory churn cleaning practices, high counts are not necessarily due to improper care of the churn. Plainly, unsatisfactory churn treatments, however, must result in unsatisfactory counts. This seems to be borne out in this study. For instance the **rinsing of the churn** with cold or lukewarm water after the first day's washing would not produce a dry churn, and a moist churn promotes mold growth. This practice was reported by plants No. 9, 22, 1, 16, and 3 and may therefore have been, at least in part, the cause of the less satisfactory results obtained by these plants.

Plant No. 9 did not indicate the **amount of water** used and it had a count of 100 or less yeasts and molds per cc. in only 20 per cent of its entries and no counts below 50. Plants Nos. 20 and 16 did not indicate the amount of water used either. If too little water is used for washing so as to fill the churn less than $\frac{1}{3}$ full, though of a fairly high temperature, the water will cool quickly and the churn will not become hot enough to destroy the yeasts and molds nor dry well after washing. Plants Nos. 22, 1, and 18 were using from 50–70 gals. of water at temperatures of 180–190° F. in churns usually handling 800–1100 lbs. of butter. They were, no doubt, using insufficient amounts of water, and oftentimes the water is not as hot as it is estimated to be, not being tested with a thermometer.

In some cases the washwater is probably not kept in contact with the revolving churn for a sufficient **period of time.** Thus plants Nos. 22, 13, 20 and 16 rotate the churn for only 5 minutes with water at 150–180° F., while plants Nos. 9 and 3 do not indicate the time used for washing.

Plant operator No. 22 indicates that his churn is like new inside and that he keeps a **fan** blowing across the doors of the churn when not in use. This practice may be excellent for drying the churn. At the same time, however, yeasts and molds as well as dust may actually be blown into the churn by the fan. It will be noticed that the counts of plant No. 22 are not very satisfactory, which may, of course, be due also to other causes. However, as pointed out by Olson and Hammer (13), better results might no doubt have been obtained by leaving the churn doors open but in a position $\frac{2}{3}$ of the way up and covered with a screen and muslin.

Plant No. 5 uses **steam** for sterilizing the churn. This practice did not

give particularly good results and it may seriously open and crack the wood due to sudden expansion and later contraction. Blistering of the outside paint may be another objectionable result, and it does not provide the slushing action of hot water. Only plant No. 1 used a starter which may at times carry yeasts and molds into the butter. Thus, criticisms can be made with all of the methods reported by the plants with unsatisfactory yeast and mold counts except in the case of plant No. 12. If the details of the methods used by this plant were reported correctly, little fault could be found with them. However, the author knows from personal observation that the plant was seriously infected with mold, which may have caused the contamination from the air, although, of course, the high counts may also have been due to inefficient pasteurization and other causes.

Table 2 shows no direct correlation between the median yeast and mold counts of individual plants and the average flavor scores of their butter when fresh or when one month old. However, when the plants are grouped in accordance with their median yeast and mold counts, the average scores of the groups decrease as the counts increase.

The grouping of plants in table 2 is the same as that used in table 1. Since the **loss in score** during storage is usually higher with the high scoring butter than with low scoring butter, the samples of butter of each plant were separated into a high scoring and low scoring group, the former scoring over 35 in flavor and the latter 35 or less. The first group of plants with median yeast and mold counts of less than 50 per ml. had 138 samples of high scoring and 24 samples of low scoring butter, the second group with yeast and mold counts of 50–100 per ml. had 62 high scoring and 35 low scoring samples and the third group with the highest yeast and mold counts sent in 32 high scoring and 52 low scoring samples.

The average flavor scores when fresh of the three groups of plants were 37.10, 36.36 and 35.86 for the better butter and 34.66, 34.62 and 34.55 for the poorer butter samples. After storage for one month at 36–41° F. the average flavor scores for the three groups of plants and the two types of butter were 35.94, 35.21 and 34.49 and 34.41, 34.33 and 34.14 respectively indicating uniformly lower average scores when fresh and after storage for the plants with the higher yeast and mold counts.

The loss in score during storage also increases as the yeast and mold count increases. This increase in score losses is perhaps more significant than the figures indicate since usually the losses are smaller as the score of the fresh butter decreases. For that reason it seems that the high losses in score on the low scoring samples are a significant indication of reduced keeping quality in the case of the samples with high yeast and mold counts.

SUMMARY AND CONCLUSIONS

The methods regularly employed for washing the churns in seventeen different creameries in the State of Washington were studied in the light of

TABLE 2

Yeast and mold counts of butter as related to flavor score and keeping quality

NO. OF CREAMERY	MEDIAN YEAST AND MOLD COUNT PER ML.	BUTTER SAMPLES SCORING ABOVE 35 IN FLAVOR				BUTTER SAMPLES SCORING 35 OR LESS IN FLAVOR			
		No. of samples	Ave. flavor score when fresh	Ave. flavor score when 1 mo old	Loss in score	No. of samples	Ave flavor score when fresh	Ave flavor score when 1 mo. old	Loss in score
23	17.5	28	37.05	35.78	1.27	0			
24	20.0	15	37.67	36.23	1.44	0			
11	22.5	10	35.70	34.55	1.15	10	34.56	34.22	0.34
14	30.0	28	37.19	36.06	1.13	0			
4	35.0	9	35.67	35.11	0.56	11	34.75	34.59	0.16
19	40.0	23	37.57	36.31	1.26	1	34.00	34.50	− 0.50
21	40.0	25	37.38	36.29	1.09	2	35.00	34.25	0.75
	Below 50	138	37.10	35.94	1.16	24	34.66	34.41	0.25
5	72.5	16	36.05	34.77	1.28	4	34.83	34.00	0.83
3	80.0	11	35.77	34.91	0.86	9	34.67	34.14	0.53
13	90.0	18	37.47	36.13	1.34	0			
20	90.0	8	35.88	35.06	0.82	11	34.56	34.53	0.03
16	95.0	9	35.83	34.67	1.16	11	34.56	34.44	0.12
	50–100	62	36.36	35.21	1.15	35	34.62	34.33	0.29
1	110.0	8	35.75	34.81	0.94	9	34.50	34.28	0.22
18	215.0	6	35.92	34.58	1.34	16	34.50	33.93	0.57
22	287.5	12	35.93	34.43	1.50	4	34.63	34.75	− 0.12
12	377.5	3	36.00	34.83	1.17	11	34.64	34.30	0.34
9	445.0	3	35.67	33.33	2.34	12	34.54	33.96	0.58
	100–500	32	35.86	34.49	1.37	52	34.55	34.14	0.41

the yeast and mold counts of the butter of these plants covering samples obtained during 14–28 different months.

Although there are many possible causes of high yeast and mold counts in butter, the consistently low counts of some of these plants indicate that their methods of churn treatment were satisfactory.

The methods of the seven plants having a consistently low yeast and mold content in their butter are given. From a study of these methods, the following factors appear to be important:

1. The use of ample quantities of washwater amounting to at least one-third to one-half the capacity of the churn.

2. A high temperature of the washwater, preferably 180°–200° F.

3. The use of 0.1–0.2 per cent of washing powder solution gives added protection by assisting in the removal of the grease, improving germicidal power and improving the odor of the churn.

4. Washing or rinsing with an alkaline crystalline hypochlorite solution of about 50 parts per million of chlorine together with hot water treatment also insured satisfactory results. Only four plants reported the use of this product, but three of these—Nos. 11, 4 and 19—were among the seven plants with the best yeast and mold records.

5. Keeping the hot water in contact with the revolving churn for at least 15 minutes.

Some fault could be found with the methods used by most of the other plants outside of the seven leaders, although, of course, the poor results obtained may have been due to other causes as well. Five plants mentioned rinsing the churn with cold or lukewarm water immediately after washing. Such a practice is undesirable because it does not leave the churn dry and a wet churn promotes microbial multiplication. In three plants too little water was used in washing. The small amount of water cools rapidly and thus loses its germicidal effect. In four plants the churns were in contact with the hot water for only 5 minutes, which is an insufficient period. One plant using steam sterilization did not produce satisfactory results.

Considering individual samples and the samples from individual plants, no direct relationship was found between yeast and mold counts and the quality and keeping quality of the butter held one month at 36–41° F. However, when grouping the plants in accordance with their median yeast and mold counts, the average scores of each group, both when fresh and after storage for a month at 36–41° F., decreased and the average score losses during storage increased as the median yeast and mold counts increased. Although the results do not prove any direct effect of yeast and mold content on the quality and keeping quality of commercial salted butter, the relationships found are of considerable significance.

It is apparent that in many of our commercial plants more attention might profitably be paid to a more painstaking care of the churn.

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DETERMINATION OF FAT, MOISTURE, AND SALT IN HARD CHEESE

BY THE SUBCOMMITTEE FOR THE ANALYSIS OF CHEESE

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The subcommittee on the analysis of cheese was appointed in 1933. The committee now submits to the members of the American Dairy Science Association an outline of the methods for the determination of fat, moisture, and salt in hard cheese. The committee expects a little later to submit another report dealing with the analysis of semi-hard and soft cheese.

DETERMINATION OF FAT, MOISTURE, AND SALT IN HARD CHEESE

1. *Sampling* (A.O.A.C. Method, slightly modified)

When the cheese can be cut, take a narrow, wedge-shaped segment reaching from the outer edge to the center of the cheese. Cut this into strips and pass three times through a sausage machine. When the cheese cannot be cut, take the sample with a cheese trier. If only one plug can be obtained, take it perpendicularly to the surface of the cheese at a point ⅓ the distance from the edge to the center and extending either entirely or half way through it. Where possible draw three plugs perpendicularly, one from the center, one from a point 1 inch from the outer edge, and one from a point half way between the other two. For inspection purposes reject ½ inch nearest the rind, but for investigations requiring the absolute quantity of fat in the cheese, include the rind with the sample. Grind the plugs in a sausage machine (the preferable method) or cut them very finely and mix thoroughly.

All samples unless analyzed immediately are wrapped in foil or similar non-absorbent material and are inclosed in small, air-tight, stoppered containers and analyzed as soon as possible without unnecessary exposure to the air. Samples not analyzed at once are kept in a refrigerator.

2. *Determination of Fat*

(1) Weigh 9 grams of cheese as prepared above into a dry, tared, 9 gram 50 per cent large-bodied Babcock test bottle. A specially constructed bottle having an opening in the upper part of the bulb and closed with a rubber stopper may be used. The rubber stopper should be discarded when it becomes hard. This operation should be done quickly so as to prevent, as much as possible, evaporation of moisture from the cheese.

(2) Add 12 cc. water at a temperature of 160° to 170° F. Mix well with the cheese.

(3) Add in several installments 17.5 cc. sulphuric acid (sp. gr. 1.82 to 1.83), shaking the bottle after each addition of acid.   Leave the bottle stand until all particles of cheese have dissolved.

(4) Centrifuge and add water as when testing cream.

(5) Place the bottle in a water bath 130° to 140° F., with the water level above the level of the fat.   After 5 minutes add glymol and read the percentage of fat.   Duplicate samples should check within 0.5 per cent.

3. Determination of Moisture

(a) For laboratories.

(1) The moisture dishes and covers are dried for 1 hour at 100° C. and allowed to cool for ½ hour in a desiccator containing sulphuric acid or other desiccant.

(2) A cover is placed on the dish and both are weighed on a chemical balance, preferably chainomatic.

(3) Approximately 2 to 3 grams of the sample are placed in the dish, the cover is immediately replaced, and a second weighing is made.   Tests should always be made in duplicate or triplicate for the greatest accuracy.

(4) The samples are dried, with covers, in an oven at 100° C. If a vacuum of 20 inches or more is available, 10 hours' drying should suffice; if no vacuum is used, 24 hours' drying is recommended.   Spattering may be minimized by placing the samples in the oven when the oven temperature is below 50° C. so that the samples are heated slowly.   Covered dishes must be used to avoid losses of cheese when samples are placed in a hot oven.   Vacuum should be applied slowly and released slowly.

(5) After drying, the samples are placed in a desiccator for about one hour, or until they reach room temperature, and each is weighed, without further delay.

(6) Loss in weight divided by weight of sample multiplied by 100 equals percentage of moisture.

Either 30 cc. pyrex beakers or aluminum dishes approximately 50 mm. in diameter and 22 mm. deep may be used.   Each dish should be plainly and permanently numbered.

For routine laboratory analysis, if a balance having a tare beam and beams for direct readings and possessing a sensibility reciprocal* of 15 mg. is available, the above procedure is used with the following modifications:

(1) A dish 3 inches in diameter and 1 inch deep is used.

(2) Exactly 10 grams of the freshly-prepared sample are quickly weighed into the dish.

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* The pointer should be deflected a distance equal to one division on the graduated portion when 15 mg. are placed on either scale pan when the scale is loaded to capacity.

(3) A cover is placed loosely on the dish. After being dried in an oven and cooled in a desiccator, the dish and cover are placed on the balance, and the percentage of moisture is read on the beams to the nearest 0.1 per cent. Duplicate samples when properly dried should check within 0.2 per cent.

(b) For cheese factories.

(1) Tare a dry, aluminum dish with cover on a balance which is equipped with a tare beam and with beams that permit the direct reading of the percentage of moisture. The balance should have a sensibility reciprocal of 15 mg. If the dish is first heated in order to dry it, cooling it afterwards to room temperature is important. A dish 3 inches in diameter and about 1 inch deep is satisfactory.

(2) From the freshly prepared sample weigh 10 grams cheese into the dish. This operation should be done quickly. The lid is placed loosely on the dish so as to permit the escape of moisture. The lid prevents the escape of fat and casein if spattering occurs.

(3) The dish is placed in an oven and heated slowly to a temperature of 220° to 230° F. This temperature should be maintained for 24 hours. An electrically heated oven equipped with a heat regulating device is satisfactory for this purpose. If electricity is not available, a pressure steam oven may be used. Since steam is usually not available over a period of 24 hours in the average cheese-factory, with a steam pressure in the jacket of the oven of from 40 to 50 pounds, and a temperature in the oven of 290° F., the drying can be completed in 4 to 6 hours. The temperature should be increased over a period of 1 hour to that desired. This procedure will avoid boiling over of the cheese. Electrically heated ovens can also be used for this short drying treatment.

(4) When the dish is removed from the oven the lid is placed tightly on the dish and the dish with moisture-free material is placed on a cool surface to cool to room temperature. The dish is then placed on the balance and the percentage of moisture read on the beams to the nearest 0.1 per cent after equilibrium has been reached. Duplicate samples should check within 0.2 per cent.

4. *Determination of Salt* (sodium chloride)

Weigh accurately approximately 3 grams of ground or chopped cheese

into a 300 cc. Erlenmeyer flask and add 10 cc. of 0.1711 N silver nitrate solution, or an amount more than sufficient to combine with all of the chlorine. Add 15 cc. of halogen-free, chemically pure nitric acid and 50 cc. of water and boil. As the mixture boils add approximately 15 cc. of saturated potassium permanganate solution in 5 cc. portions. Boil until all cheese particles are digested. Dilute the solution to about 100 cc., decant off the liquid into a beaker, and wash the precipitate by adding 100 cc. of water and decanting again. Add 3 cc. of a saturated solution of ferric ammonium sulfate as an indicator and titrate the excess silver nitrate with 0.1711 N potassium or ammonium sulfocyanate. Run a blank on the reagents used, following the same procedure, except to add sugar to destroy the excess of permanganate. The number of cc. of silver nitrate used minus the titration value divided by the weight of sample equals the percentage of sodium chloride in the sample. The reagents are made up by standardization against a salt solution containing 10 grams of chemically pure, dry sodium chloride per liter.

THE RATE OF CHANGE IN THE VITAMIN A CONTENT OF MILK*

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Although it is well known that the vitamin A value of milk and butterfat varies with the ration fed the cow, there is little specific information concerning the rapidity of change in the vitamin A content of milk following a change in the diet. Much of the information relating to this problem is derived from experiments designed primarily for some other purpose (1–6).

Since milk and butter owe their vitamin A value to both carotene and vitamin A, *per se,* determinations of the intensity of yellow color or carotene content, as well as the vitamin A activity, have been used by some investigators for ascertaining the rapidity of response to a change in the vitamin A value of the ration. Thus, Palmer and Eckles (7) found that the carotene value of milk fat responded very rapidly to a change in the carotene content of the ration. Similar observations were made by Doan (8) who observed that the maximum change in color took place in two weeks. However, Tucker and Pfau (9) observed that longer periods were necessary. Watson, Bishop and Drummond (10) stated that a maximum color value was secured in 29 days after a change in the character of the ration, but no readings were made at intervening dates. Bauman, Steenbock, Beeson and Rupel (11) showed, with readings taken at five-day intervals, that both vitamin A and carotene content of butter increased very rapidly. Moore (12) apparently obtained depletion in 13 days on a vitamin A poor ration, and repletion in 17 days. On the other hand, Fraps, Copeland and Treichler (6) state that "the effect of a feed cannot be judged by tests covering short periods of time"

There have been wide variations in the length of feeding experiments designed to study the effects of various feeds on the carotene and vitamin A content of milk fat secreted by dairy cows. A study of the literature shows that these experiments vary from 16 days to three months or longer. More exact information regarding the rate of change in the vitamin A content of milk resulting from changes in the ration would enable research workers to judiciously select feeding periods of sufficient duration to measure the major effects of the diet and at the same time make possible the elimination of unnecessarily long feeding periods. By using the shortest possible test period that can be conducted with safety, more tests could be made with

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the same cows during a single lactation period, feed could be conserved and more work accomplished in a given time.

<div align="center">EXPERIMENTAL</div>

This experiment was planned to measure the rapidity of change in carotene and vitamin A value of butterfat when the cow was changed from a diet of high vitamin A potency to one of low vitamin A potency and *vice versa*. Good grade alfalfa hay was used as the chief source of vitamin A in the ration of high vitamin A activity and timothy hay in the ration of low vitamin A activity.

Two Guernsey cows in the fifth and sixth months of their second lactation were used in these feeding trials. In order to assure nutritive conditions favorable to the production of butterfat of high vitamin A value, the cows were placed on the alfalfa hay ration, consisting of alfalfa hay, limited amounts of corn silage and a grain mixture of white corn, ground oats and linseed oilmeal. At the end of thirty days, milk samples were collected from the cows. In order to measure the vitamin A activity of the milk fat, the cream was separated, churned into butter and the butter samples assayed for carotene and vitamin A.

<div align="center">TABLE 1

Showing the Rations Fed the Cows, the Dates on which Butter Samples were Secured and the Carotene Contents of the Butterfat</div>

SAMPLE NO.	DATE TAKEN	RATION FED	NUMBER OF DAYS AFTER LAST CHANGE IN RATION	CAROTENE MICROGRAMS/ GRAM (BUTTERFAT)
Check	1–30–35	Alfalfa Hay, Corn Silage, Grain	30	7.4
T–1	2–1–30		.1	7.4
T–2	2–2–35		2	7.2
T–3	2–3–35		3	6.9
T–4	2–4–35		4	6.8
T–6	2–6–35	Timothy Hay, Corn Silage, Grain	6	6.6
T–8	2–8–35		8	6.5
T–11	2–11–35		11	6.4
T–14	2–14–35		14	6.4
T–18	2–18–35		18	6.4
T–21	2–21–35		21	6.4
A–1	2–23–35		1	6.6
A–2	2–24–35		2	6.7
A–3	2–25–35		3	6.9
A–4	2–26–35		4	7.0
A–5	2–27–35	Alfalfa Hay, Corn Silage, Grain	5	7.1
A–7	3–1–35		7	7.3
A–10	3–4–35		10	7.4
A–13	3–7–35		13	7.4
A–17	3–11–35		17	7.4
A–21	3–14–35		21	7.4

The cows were then placed on the low vitamin A ration (timothy hay). Butter samples were churned from milk samples which were collected periodically as shown in Table 1. In order to follow closely the progressive changes in the samples as soon as they were available, portions of each sample were analyzed immediately for carotene. The samples were rendered at 50° C. and the fat separated from the curd and water by filtration. Five gram samples were dissolved in petroleum ether and made up to 100 ml. Using the method of Schertz (13), the samples were analyzed in a Bausch and Lomb Spectrophotometer, using a similar solution prepared with decolorized butterfat to compensate for the transmittancy of the fat. These values are given in Table 1.

From these data, it became apparent that the change in carotene was very rapid and had reached an equilibrium with the ration in about eleven days, and that little was to be gained by carrying the test beyond twenty-one days. At this point the cows were again placed on the alfalfa hay ration and the change in carotene content was followed for another twenty-one days. These results are also given in Table 1.
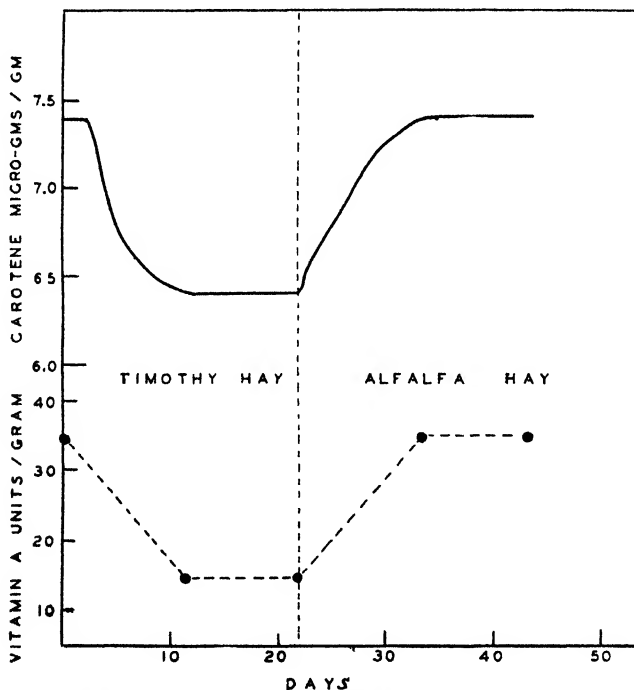
CHART 1. Showing the rapidity of response of carotene and vitamin A in the butterfat when the cows were changed from the high vitamin A diet to the low vitamin A diet and *vice versa*.

Biological assays for vitamin A were made on five selected butter samples. Since it was not feasible to assay all the samples taken, the five samples to be assayed were chosen at strategic points as indicated by the carotene content of the butters. The assumption was made that when the carotene had reached an equilibrium, the vitamin A activity had probably also reached an equilibrium with the ration. The vitamin A values of these samples were determined by biological assays, using the curative method as previously described (4). The results are given in Chart I, the values being expressed in Sherman and Munsell (14) vitamin A units.

DISCUSSION

From the results of these studies, as shown in Table 1 and Chart I, it becomes apparent that the carotene content of milk fat responds very rapidly to the carotene content of the ration fed the cow. It is interesting to note that when the cows were changed from a high carotene ration to a low carotene ration there was little change in the carotene content of milk fat produced within 24 hours, but beginning with the second day the carotene content declined very rapidly, apparently reaching a minimum for this ration at the end of eleven days.

When the alfalfa hay ration was substituted for the timothy hay ration, the carotene content of the butterfat produced rose immediately, being significantly higher at the end of the first day. The rise was rapid at first, then moderated until after the tenth day of alfalfa feeding when it seemed to be complete. No further change in the carotene content was observed on further feeding of the same ration.

Regarding the change in vitamin A taking place in the milk fat of these samples, it can be seen from Chart I that the decline in vitamin A content of the milk fat produced was virtually completed by the eleventh day after changing the cows from the alfalfa hay ration to the timothy hay ration. This is shown by the fact that ten days later (Sample T–21) the vitamin A content of the butterfat was almost identical with that of the butterfat produced on the eleventh day (Sample T–11). During the repletion period, since Samples A–10 and A–11 have almost identical vitamin A contents, it can be assumed that the increase in the vitamin A content of the butterfat produced was practically complete by the tenth day of alfalfa feeding.

In these experiments, it is apparent that there is a close correlation between the carotene content and the vitamin A value of the milk fat. With a decline in carotene there was a decline in vitamin A value and *vice versa*. However, this parallelism does not always exist. In other experiments (unpublished data) it has been found that the vitamin A value of butterfat may vary without materially changing the carotene content. Under certain conditions, especially those which affect the utilization of the vitamin of the ration or interfere with the vitamin A metabolism of the cow, it has

been observed that there may be little or no correlation between carotene content and vitamin A activity of butterfat.

The rapid response observed in these experiments is probably characteristic for the majority of feeding experiments, especially where the different rations contain some vitamin A activity. However, it must be recognized that when cows are placed on rations which are either totally deficient in vitamin A value or far below the bodily requirement of the cow, the initial decline in carotene and vitamin A will probably be similar to that observed in these experiments. After reaching the point where the carotene and vitamin A appearing in the butterfat are drawn from the tissue reserve of the animal, any further decline will be slow and gradual, depending on the rate of depletion of the body storage.

From the results of these feeding trials, it would seem that the transfer of the vitamin potency from the cow's ration to the milk is perhaps more rapid than many investigators have assumed. On the basis of these studies it would seem logical to conclude that the major effect of a feed upon the vitamin A content of milk might be measured in relatively short feeding periods.

This is not only significant from the standpoint of the research worker but should be of interest to the producer of milk and butterfat for human consumption. Dairymen attempting to produce milk or butter of high vitamin A value must of necessity watch the character of the rations fed his cows, avoiding feeding rations low in vitamin A potency ever for a short period of time.

SUMMARY

Studies were made of the rate of change in carotene and vitamin A content of milk fat from two cows following a change from a ration of high vitamin A value to one of low vitamin A value and *vice versa*. Alfalfa hay was the principal source of vitamin A in the high vitamin A ration while timothy hay was used as the principal source in the low vitamin A ration.

Following the change from a high vitamin A diet to a low vitamin A diet, the milk fat secreted by the cows declined very rapidly in carotene and vitamin A value, reaching an equilibrium level with the ration in about 11 days.

In the repletion period, the carotene content and vitamin A value of the milk fat increased very rapidly to an equilibrium level with the ration ten days after the cows were put on the high vitamin A ration (alfalfa).

It may be concluded that the major effect of a change in the diet upon the vitamin A content of cows' milk can be ascertained by relatively short feeding trials.

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THE COMPOSITION OF THE COLOSTRUM OF THE DAIRY GOAT

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The composition of the fluids and secretions of the mammary gland under normal and abnormal conditions is of interest due to the light that may be shed on the process of milk secretion and the part played by the various hormones in stimulating the initiation and maintenance of lactation. The amount of secretion which may be obtained from the smaller experimental animals in most cases is insufficient for analysis and difficult to remove. For many studies of milk secretion, the dairy goat is ideal because of its small size and large yield of milk. In conjunction with a study of the normal and experimental development of the mammary gland and of milk secretion in progress in our laboratory, it seemed highly desirable to determine the normal composition of the first secretion (colostrum) of the dairy goat for comparison later with the secretions which may be stimulated experimentally.

The composition of the colostrum of the goat has not been as widely studied as the colostrum of the cow. Henry in 1840 (1), (2) was the first to analyze the colostrum of the goat for a few major constituents including total solids, fat, casein, albumin and ash. Ilucho (3), (4), Omneis (5) and Scheurlen (6) reported data on the specific gravity, total solids, fat, total protein, casein, albumin, lactose, and ash, but neither investigator included any data on the globulin content. Steinegger (7) studied the changes in colostrum of two goats for the morning and evening milk of the first day and observed further changes on the second, third and fifth days in one goat. Siegfeld (8), (9) analyzed the colostrum of two goats for a period of three consecutive days in the former study, and for four consecutive days in the latter study. He presented data for all the major constituents except albumin and globulin. Frahm (10) has presented the most complete data to date. He investigated the colostrum of three goats for a period of four, six, and seven days, respectively, and presented data for all the major constituents, but only partial data on the globulin content of the colostrum from one goat. Table I gives a summary of all available data from 1840 to date.

Practically all workers who have made analyses of milk, whether colostrum or normal have included non-protein nitrogen in their determination of total protein. As a result the total proteins have usually been too high.

TABLE 1

Composition of the colostrum of the dairy goat (summary of literature)

NO. OF GOATS	NO. OF SAMPLES	SPECIFIC GRAVITY	WATER	TOTAL SOLIDS	FAT	TOTAL PROTEIN	CASEIN	ALBUMIN	GLOBULIN	LACTOSE	ASH	REMARKS
1	1	1.0341	64.10	35.90	24.50		5.20	3.20		5.69	3.00	Henry (1840)
1	1	1.0321	81.67	18.33	6.45	3.95					0.87	Hucho (1897)
1	1	1.0371	83.38	11.62	2.80					2.60	0.71	Stennegger (1898) A.M. 1st day
1	1	1.0314	87.90	12.10	3.30			2.67		2.40	0.58	Stennegger (1898) P.M. 1st day
1	1	1.0281	87.21	12.79	3.90			2.97		2.54	0.61	Stennegger (1898) A.M. 2nd day
1	1		90.44	9.56	1.90						0.64	Stennegger (1898) A.M. 3rd day
1	1	1.0276	89.92	10.08	2.45			3.19		3.13	0.68	Stennegger (1898) A.M. 5th day
1	1	1.0276	89.95	10.05	6.10			2.30		3.15	0.78	Stennegger (1898) A.M. 3rd day
1	1	1.0538	77.23	22.77	5.20			12.02		2.84	1.00	Stennegger (1898) A.M. 1st day
1	1	1.0360			16.85			9.60		2.24	0.99	Stennegger (1898) P.M. 1st day
1	1	1.0300	87.20	12.80	4.20						0.70	Stennegger (1898) P.M. 5th day
1	1	1.0643	70.80	29.20	6.45		4.82			2.91	1.15	Omneis (1904)
1	1	1.0355	71.84	28.16	14.70	8.40	3.68			2.94	0.99	Siegfeld (1906) 1st day
1	1	1.0330	84.50	15.50	5.10	4.14	2.16			4.45	0.84	Siegfeld (1906) 2nd day
1	1	1.0330	84.46	15.54	5.50	4.46	2.98*			4.42	0.83	Siegfeld (1906) 3rd day
1	1	1.0700	60.05	39.95	16.40	20.62				3.50	1.27	Siegfeld (1908) 1st milking
1	1	1.0348	82.60	17.40	6.85						0.91	Siegfeld (1908) 2nd milking
1	1	1.0333	82.07	17.93	7.40					4.57	0.90	Siegfeld (1908) 3rd milking
1	1	1.0333	84.06	15.94	5.50						0.90	Siegfeld (1908) 4th milking
1	1	1.0554	71.30	28.70	10.04			4.33		3.67	1.03	Scheurlen (1908) 1st day
3	5	1.0360	75.58	24.42	11.40	8.01	4.88	2.43	4.60(1)[1]	3.94	0.81	Frahm (1926) 1st day
3	7	1.0326	83.52	16.48	6.58	4.43	3.59	1.17	0.99(1)	4.52	0.86(5)	Frahm (1926) 2nd day
3	6	1.0316	84.55	15.45	5.36	4.27	2.30	0.95	0.48(2)	4.64	0.91	Frahm (1926) 3rd day
3	6	1.0338	84.78	12.22	5.35	4.13	2.61	0.87	0.46(1)	4.85	0.87	Frahm (1926) 4th day
2	4	1.0340	84.72	15.28	5.35	4.18	2.74	0.80	0.46(2)	4.69	0.77	Frahm (1926) 5th day
2	4	1.0343	85.60	14.40	4.52	3.98	2.56	0.81	0.46(2)	4.74	0.84	Frahm (1926) 6th day
1	2	1.0354	85.41	14.59	4.50	4.08	2.44	0.84		4.84	0.88	Frahm (1926) 7th day
						Average of above data						
11	15	1.0429(14)	75.08(14)	24.92(14)	10.91	9.13(8)	4.06(9)	2.81(7)	4.60(1)	3.46(14)	1.04	1st day
6	10	1.0327	83.90	16.10	6.19	4.39(8)	3.53(8)	1.17(7)	0.99(1)	4.29(9)	0.83(8)	2nd day
7	10	1.0311	85.42	14.58	5.41	4.30(8)	2.56(7)	0.95(6)	0.48(2)	4.44(9)	0.87	3rd day
4	7	1.0337	84.66	15.34(6)	5.37(6)	4.13(6)	2.61(6)	0.97(5)	0.46(1)	4.85(6)	0.87	4th day
4	6	1.0323	86.00	14.00	4.68	4.18(4)	2.74(2)	0.80(4)	0.46(2)	4.08(5)	0.74	5th day
2	4	1.0343	85.60	14.40	4.52	3.98	2.56	0.81	0.46(2)	4.74	0.84	6th day
1	2	1.0354	85.41	14.59	4.50	4.08	2.44	0.84		4.84	0.88	7th day

[1] The number in parenthesis indicates the number of samples used to arrive at the average figure.

Moir (11) called attention to this and suggested that the total protein be precipitated with warm trichloracetic acid, thereby leaving the non-protein nitrogen in solution. Likewise, casein has usually been precipitated with acetic acid at a pH of 4.2, which is considerably below its isoelectric point. Michaelis and Pechstein (12), by a series of cataphoresis experiments, found the isoelectric point of casein to be pH 4.6. Moir suggested the use of acetic acid, buffered with sodium acetate. This technique produces a filtrate with a pH from 4.5 to 4.7 and gave results with cow's milk which were usually from 1 to 2 per cent higher than those obtained by using acetic acid alone.

Due to the small proportion of globulin in milk, most investigators have been content to precipitate albumin and globulin together and report it as albumin. Moir developed a technique by which albumin and globulin may be determined separately. He suggested that the casein and globulin be precipitated with a saturated solution of magnesium sulfate. Then from total protein minus casein and globulin, albumin is obtained. Likewise, casein and globulin minus casein gives globulin.

Although the procedure for determining total protein, casein and globulin, and casein as used by Moir applied to normal cow's milk, we have, with slight modifications, found it adaptable for our work. We have studied the composition of colostrum for a period of nine days following parturition. The goats (grade Toggenberg) were milked twice daily and a composite sample taken of the morning and evening milk. Analyses were made on the first, second, third, fifth, seventh and ninth days.

METHODS OF ANALYSIS

Specific gravity was determined by means of a hydrometer at 15.6° C.; total solids by drying in an oven at 90 to 92° C. for 24 to 48 hours or until the sample ceased to lose weight; fat by the Babcock test; ash by drying the sample on a water bath and then ashing below redness. Lactose was determined by precipitating the proteins with zinc salts (13) and determining the amount of sugar present in the filtrate by using the Shaffer-Somogyi (14) copper-iodometric blood sugar technique.

For the purpose of determining total protein, 5 ml. of a well mixed sample of milk were pipetted ino a weighed, covered beaker (50 to 100 ml.) and reweighed. Five ml. of 8 per cent trichloracetic acid were added to make the final concentration about 4 per cent. The mixture was maintained at a temperature of 60 to 65° C. on a water bath for 30 minutes, cooled, filtered, and washed several times with a 1 per cent solution of trichloracetic acid. The filter paper and precipitate were added to a Kjeldahl flask and the nitrogen content determined by the Kjeldahl method.

Casein and globulin were precipitated together by using a saturated solution of magnesium sulfate. Five ml. of milk (weighed as for total protein) were neutralized to phenolphthalein with N/10 sodium hydroxide, and

mixed with 45 to 50 ml. of a saturated magnesium sulphate solution. An additional amount of salt (anhydrous) was added to saturate 5 ml. of water. After standing for about an hour, the protein precipitate was filtered, washed with a saturated salt solution and its nitrogen content determined by the Kjeldahl method as for total protein.

Casein was precipitated at a pH of approximately 4.6 with acetic acid buffered by sodium acetate. Five ml. of milk (weighed as for total protein) were diluted with 25 ml. of distilled water warmed to 40 to 42° C. To this 0.75 ml. of 1.67 N (10 per cent) acetic acid was added at once and stirred gently by rotating the stirring rod in the beaker three or four times. After standing for 20 minutes, 2.3 ml. of 0.25 N sodium acetate solution were added. The filtrate was decanted and the precipitate washed with distilled water three times and then transferred to the filter paper, followed by one or two more washings. The nitrogen content was estimated as for total protein.

The albumin content of colostrum may be determined by subtracting the value for casein and globulin from the value for total protein. From the value for casein and globulin minus casein, globulin may be determined.

<center>DISCUSSION OF THE DATA</center>

The study of the composition of the first milk or colostrum and the gradual transition to normal milk is of considerable interest from several points of view. Not only does it indicate something of the rate at which the epithelial cells gradually take up the function of milk synthesis, but by means of the newer methods of protein analysis the transition in the globulin content of colostrum has been followed for the first time. The fact that immune bodies are transferred from the mother to the young in association with the globulin fraction of colostrum gives added importance to the separate analysis of this protein which is believed to pass from the blood stream into the milk unchanged (Woodman, 15).

At the same time the composition of goat's colostrum was of special interest in this laboratory as it is planned to try to stimulate lactation in the goat with the lactogenic hormone, galactin, and it is desirable to be able to compare the composition of the mammary secretions thus stimulated with the secretions stimulated by normal pregnancy (16).

The rapid transition of colostrum characterized by high total solids, fat and total protein into approximately normal milk is shown in Table II and Fig. 1, representing the average composition of the secretions of six Toggenburg goats during the nine days following parturition. An examination of these data indicate that a decided drop in several of the constituents occurred on the second day and that the milk tends to approach normality between the third and fourth days. The only constituent showing a slight increase during this period was lactose (Fig. 2).
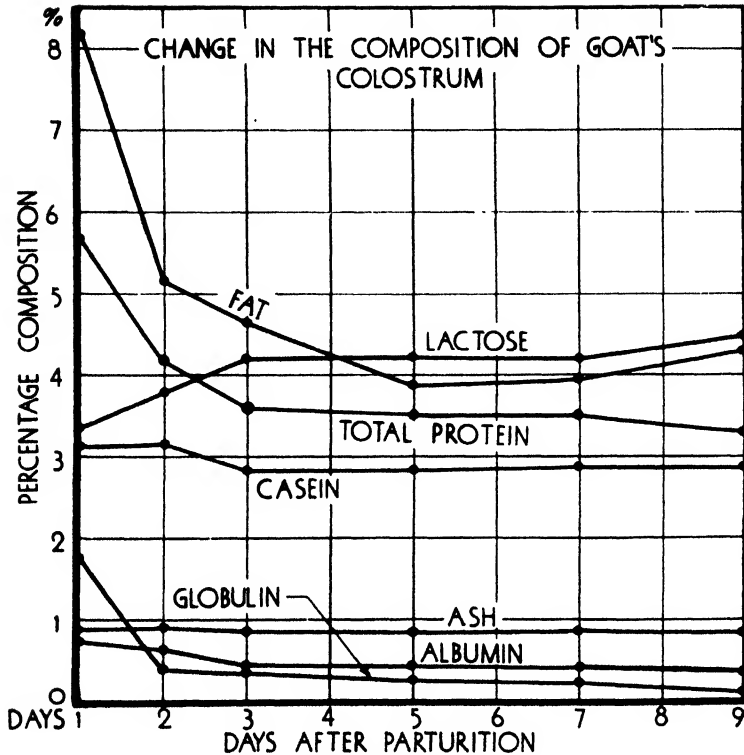
FIG. 1. Change in the composition of goats' colostrum. This average of the milk of six Toggenburg goats shows a rapid decline in fat and total protein (consisting chiefly of globulin). The lactose increases slightly and the ash decreases slightly as would be expected from their effect upon the osmotic equilibrium.

The fluctuations in the lactose and ash contents of colostrum are of interest due to the fact that these substances are chiefly responsible for the osmotic pressure of milk (Jackson and Rothera, 17). To maintain osmotic equilibrium alterations in lactose would require changes in the salts. An inverse relation between lactose and ash may be observed.

Total proteins are somewhat lower than those reported by other investigators. This is, in part, due to the fact that we have not included non-protein nitrogen in our results. On the other hand, the casein is higher than that reported by Frahm. As has been mentioned previously, Moir showed that by precipitating casein from cow's milk at the isoelectric point of pH 4.6 the casein content was increased 1 to 2 per cent. We have used the same procedure on goat colostrum and a slight increase may be attributed to this technique. A gradual decrease in albumin was observed during this period, being 0.78 and 0.34 per cent on the first and ninth day, respectively.
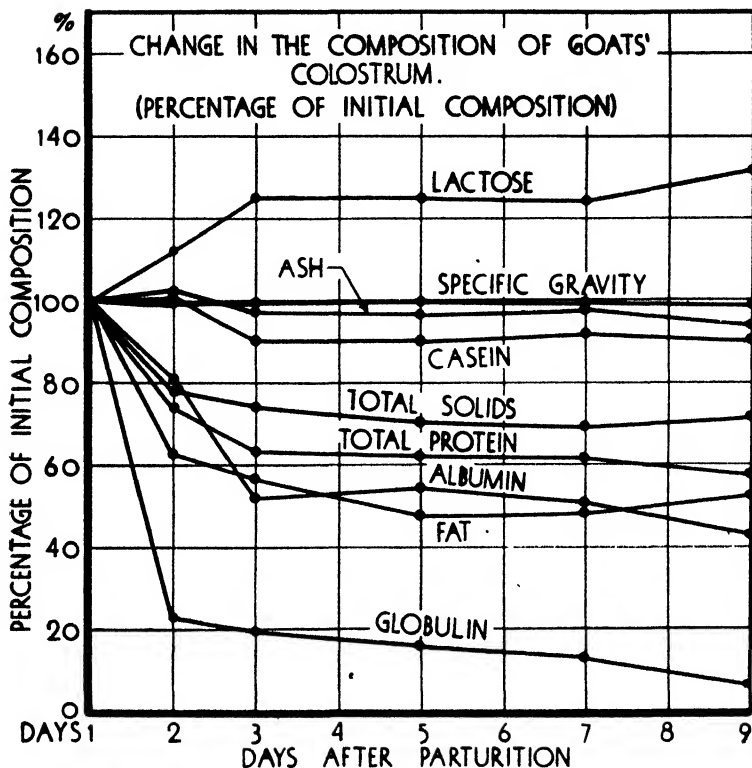
Fig. 2.   Change in the composition of goats' colostrum based upon the percentage of the initial composition.

The most rapid change from colostrum to normal milk occurred in the globulin, which was 1.76 per cent on the first day, 0.40 per cent on the second day, then gradually declined to 0.11 per cent on the ninth day. Figures for comparison are few, since in most cases globulin and albumin have been reported together. It is of interest to note in the review of the literature that Frahm was the first to report partial data on one goat. He found the globulin to be 4.60 and 0.46 per cent on the first and sixth days. Because of the interest in the albumin and globulin fractions, the individual analyses are presented in Table III. In all cases the first milking was quite high in globulin with a marked drop at the second milking. This would indicate the importance of the kid receiving the first milk in order to obtain the largest amount of globulin and the associated immune bodies. The decline in the albumin content is quite gradual. These results indicate that in the goat, the large amount of total protein in the colostrum immediately after parturition is due to the globulin rather than the albumin.

TABLE II

The composition of goats' colostrum (ave. of six goats)

DAYS AFTER PARTURITION	SPECIFIC GRAVITY	WATER	TOTAL SOLIDS	FAT	TOTAL PROTEIN	CASEIN	CASEIN GLOBULIN	ALBUMIN	GLOBULIN	LACTOSE	ASH
1*	1.039	81.17	18.83	8.21	5.69	3.14	4.90	0.79	1.76	3.39	0.88
2	1.035	85.26	14.74	5.15	4.21	3.18	3.58	0.64	0.40	3.80	0.90
3	1.034	86.03	13.97	4.64	3.60	2.84	3.19	0.41	0.35	4.23	0.86
5	1.034	86.73	13.27	3.88	3.53	2.83	3.11	0.43	0.28	4.24	0.85
7	1.035	86.91	13.09	3.95	3.52	2.89	3.12	0.40	0.23	4.21	0.86
9	1.035	86.43	13.57	4.33	3.31	2.86	2.97	0.34	0.11	4.47	0.83

* In one doe the first milk was removed by the kid born during the night. This sample was eliminated from the average.

TABLE III

Albumin and globulin content of colostrum of individual goats

NO. DAYS	GOVT NUMBER													
	83		66		43		254		57A		65		AVERAGE	
	Al-bumin	Globulin	Al-bumin	Globulin	Al-bumin	Globulin	Al-bumin	Globulin	Al-bumin	Globulin	Al-bumin	Globulin	Al-bumin	Globulin
1	0.81	2.04	0.72*	0.37*	0.81	2.97	0.94	1.03	0.60	1.45	0.77	1.33	0.79	1.76
2	0.59	0.49	0.89	0.38	0.71	0.36	0.40	0.39	0.61	0.38	0.63	0.39	0.64	0.40
3	0.29	0.59	0.41	0.40	0.50	0.37	0.46	0.27	0.47	0.33	0.35	0.22	0.41	0.35
5	0.51	0.30	0.39	0.28	0.51	0.20	0.36	0.27	0.49	0.35	0.31	0.25	0.43	0.28
7	0.49	0.46	0.38	0.25	0.51	0.21	0.44	0.11	0.32	0.16	0.29	0.16	0.40	0.23
9	0.31	0.07	0.39	0.11	0.47	0.12	0.23	0.09	0.31	0.13	0.33	0.13	0.34	0.11

* The first milk was removed by the kid born during the night.

In comparing the transition of colostrum to normal milk in the goat with that in cattle (Sato, Ogura, Ikejima, 18) it would appear that most constituents show the same general trend. Fat, however, appears to be an exception being high in the goat immediately after parturition but generally low in the cow.

SUMMARY

1. The composition of colostrum and the transition to normal milk of six goats has been studied for a period of nine days. All the constituents decrease rapidly on the second day, with the exception of lactose which showed an increase.

2. Goat colostrum has a tendency to approach normality between the third and fourth days.

3. The newer methods of protein analysis have been used in a quantitative determination of these constituents present in goat colostrum. Total protein, free from non-protein nitrogen, was obtained by precipitating with 8 per cent trichloracetic acid. Casein was precipitated at its isoelectric point of pH 4.6 with an acetate buffer solution.

4. Albumin and globulin were determined separately. By salting out with $MgSO_4$, a quantitative estimation of the globulin content and its transition to normal has been followed for the first time. After the first milk is removed from the goat the globulin decreases very rapidly while only a moderate decline in albumin occurs.

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THE RELATION OF THE OXIDATION–REDUCTION POTENTIAL OF MILK TO OXIDIZED FLAVOR

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A survey of the literature on the problem of oxidized flavors in milk leads to the conclusion that there are at least seven or eight different factors which, operating alone or in combination, play a part in the production of this flavor.

Hammer and Cordes (6), Frazier (3) and others have shown that sunlight will cause a flavor in milk similar to that produced by copper and iron.

The variation in the tendency of milk to develop oxidized flavor as observed by Kende (9), Henderson and Roadhouse (7), and Prewitt and Parfitt (11) indicates that both the feed and the individuality of the cow are factors which govern the susceptibility of the milk to oxidized flavor development. It is postulated that certain feeds, particularly green feeds, impart an antioxidant to the milk, which accounts, in part, for the lessened tendency for oxidized flavor development in summer.

Henderson and Roadhouse (7), state that cows on submaintenance rations produce a more unsaturated fat which is more susceptible to oxidation.

Guthrie and Brueckner (5) emphasize the individuality of the cow as a factor. In an extensive study on milk from 155 cows of the Cornell herd drawn and pasteurized in brown glass bottles and protected from metals, they found that 21% of the cows gave milk which developed distinctly oxidized flavor when stored at 4.5° C. for three days. There was also a variation in the tendency for oxidized flavor development in milk from the different quarters of the udder of the same cow.

Heating milk to 75° C.–80° C. for one-half hour will reduce the tendency for the flavor to develop. Kende (8) and Gondos (4) express their belief that an oxidizing enzyme (oleinase) present in milk catalyzes the reaction and that the enzyme is activated by copper. Kende (8) showed that bacteria in large numbers will prevent oxidized flavor in milk. The rôle of bacteria in this respect is not sufficiently understood. Davis (2) suggests that the inhibitive action is due to the removal of oxygen by the growing bacteria and the production of a reducing potential in the milk.

The factors that various workers have shown to be involved in oxidized flavor development may be classified as follows:

1. Variation in the nature of fat itself, or of the constituent giving rise to the flavor.

2. Factors tending to promote oxidation.
    (a) Catalysis by light.   (b) Catalysis by oleinase.   (c) Catalysis by metals.
3. Factors tending to prevent oxidation.
    (a) Antioxidants.   (b) Bacteria.
4. Factors which act in an undetermined way, possibly influencing some of the above.
    (a) Individuality of the cow and of the quarter of the udder.
    (b) Season of the year.

The physico-chemical aspects of oxidized flavor in milk have not been sufficiently studied. Too little is known of the status of the physical equilibria in the production or prevention of oxidized flavor in milk. Only moderate attention has been given to the relation of the oxidation-reduction potential to oxidize flavor in milk. If the development of cardboard flavor in milk is an oxidation process it is reasonable to suppose that the oxidation-reduction potential plays a part more or less prominent.

Morris and Sommer (10) observed that cream having a high oxidizing intensity did not keep well. The addition of a reducing agent to cream of high copper content prevented oxidation for 5 months at $-18°$ C. to $-23°$ C. The data of Tracy, Ramsey and Ruehe (13) indicate a definite relationship between oxidized flavor and the oxidation-reduction potential of milk and cream containing added copper. Thurston (12) showed that the salts of copper and iron invariably raise the oxidation potential of milk but states that the oxidation-reduction potential is of no value in predicting the possible behavior of the milk as regards its tendency to become tallowy.

The work here reported throws additional light on the interpretation of the oxidation-reduction potential in relation to the keeping quality of milk and its products. The data, for the most part, were obtained over an extended period of time from studies on mixed milk received at a large milk plant. This milk, therefore, may be considered as average milk, all "individuality" factors arising from the cow and extraordinary feeding régimes being nullified in the mixing. The only important factors that might operate to vary the behavior of such milk toward oxidized flavor development are the seasonal variations in the milk itself and the extent of metallic contamination during processing. This work was done to determine the relative importance of these two factors and of the oxidation-reduction potential in the development of oxidized flavors.

MEASUREMENT OF OXIDATION REDUCTION POTENTIALS

Before the actual experiment was begun attention was directed to the construction of an electrode which would eliminate the disturbing effects of glass-to-platinum seals. Davis (2) and Tracey and Ramsey (14) have

pointed out that this is the source of much of the difficulty in securing good agreement between duplicate electrodes during oxidation-reduction potential measurements.

Electrodes are usually assembled by sealing platinum foil or wire into the end of a glass tube and making contact through mercury placed inside the tube. Frequently the glass seals developed minute cracks which retain cleaning solutions or permit mercury to seep through and come in contact with the exposed electrode. This results in false potentials, and the electrode must be rebuilt.

Details of the electrode construction used throughout this experiment are as follows: 5 cm. of No. 26 B & S gauge platinum wire are fused to the edge of a piece of bright platinum foil 7 mm. square and .08″ thick. A copper wire about 10 cm. in length is welded to the other end of the platinum wire. The electrode is then sealed into about 8 cm. of small glass tubing, making a glass-to-platinum seal as close as possible to the copper wire.

Two electrodes of this type held in a 3-hole rubber stopper are placed in the sample, contained in a 150 ml. wide mouth extraction flask. When the electrodes are properly adjusted the glass seal does not come in contact with test sample. The Agar-KCl bridge is passed through the stopper when measurements are being made. The electrodes are stored in chromic acid cleaning solution in flasks similar to those used for the test sample.

Before using, the electrodes are rinsed thoroughly with distilled water. No advantage was found in drying the electrodes after rinsing. Figure 1 shows both the electrode construction and the position of the electrodes in the sample.

Sample Flask With Electrodes
In Position

Electrode Assembly
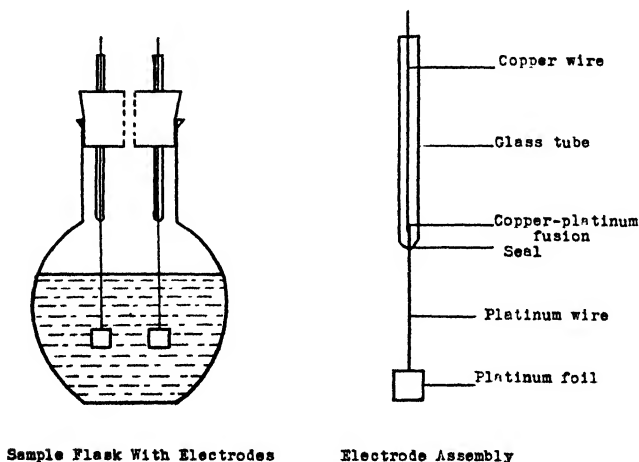
FIG. 1. The electrode construction and position in the sample.

Polarization of electrodes during measurements was avoided by using a vacuum tube circuit in conjunction with a Leeds-Northrup portable potentiometer. The circuit employed was essentially that described by Allyn and Baldwin (1). Minor modifications were made which enabled the instrument to operate on 22.5 instead of 90 volts.

To observe the oxidation potential trend of a milk sample, the electrodes were "aged" at least two hours in the sample before the initial reading was made. Without removing the electrodes after the first reading, the samples were stored at 4.5° C. and two more readings were made at 24-hour intervals thereafter. The three oxidation potential values so obtained indicated the potential trend of the milk. After the final reading was made, 50 hours from the time of bottling, the milk was tasted for evidence of oxidized flavor.

The theoretical correction of 0.06 volts for each unit pH difference between samples was not applied to the oxidation potential values because the pH variation would not be sufficient to affect the results.

Although the electrode design eliminated what was thought to be the chief cause of variation between duplicate electrodes, occasionally two identically treated electrodes were found which differed from 0.02 to 0.03 volts. When such was the case these electrodes were returned to the cleaning mixture and substitutions made. For the purpose of this investigation differences between duplicate electrodes of not more than 0.01 volt were considered satisfactory. However, in the majority of cases much better agreement was obtained. Not infrequently the electrodes checked within .0001 volt, or within the range of the galvanometer sensitivity. It will be apparent in the data that extreme accuracy of the oxidation-reduction potential values in a study of this nature is unnecessary. Even a slight agitation of the milk may alter the potential a few tenths of a millivolt. Nevertheless the values were recorded to four places as a matter of course.

EXPERIMENTAL

Study of Unmixed Milk

This part of the investigation was carried out to determine whether or not a relationship exists between the oxidation-reduction potential and the tendency for oxidized flavor development in milk from individual cows.

At the time this work was done Guthrie and Brueckner of Cornell (5) were investigating "The Cow as a Source of Oxidized Flavor of Milk." A series of quarter samples from cows of the college herd was furnished by these workers. The samples were selected to produce various degrees of oxidized flavor. The samples as received at the laboratory had been drawn and pasteurized in brown glass bottles and kept at 4.5° C. Although the first oxidation potential determinations on these samples were not made
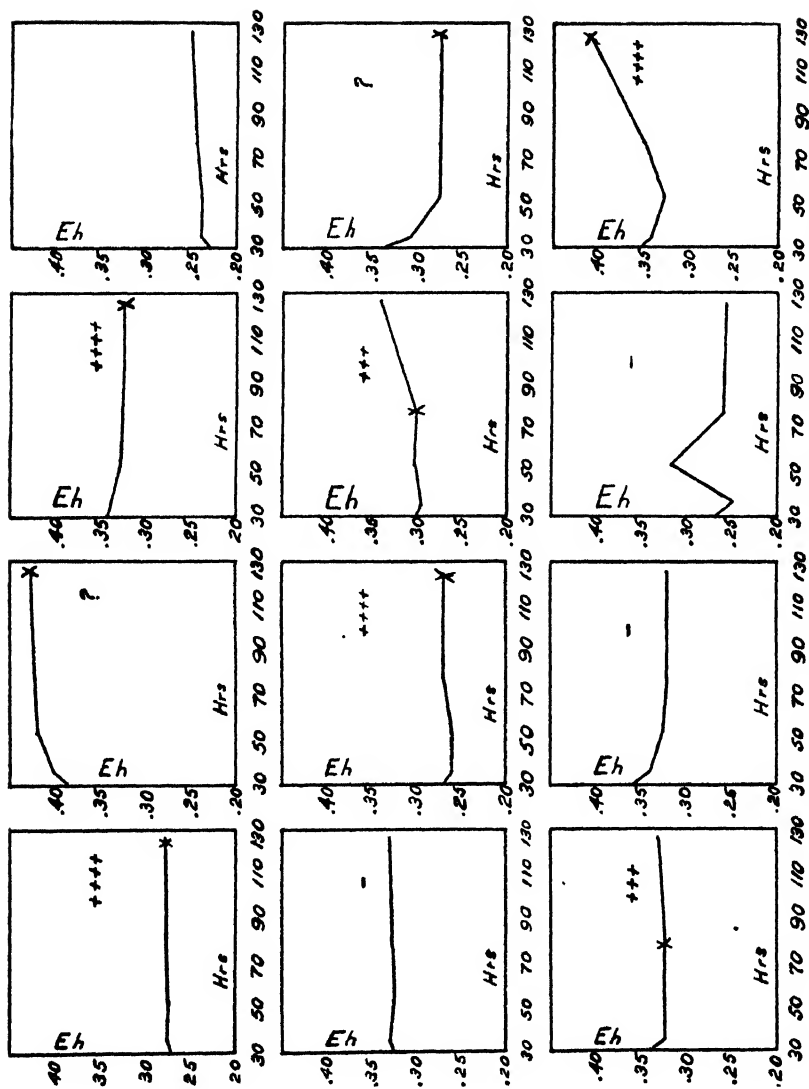
FIG. 2. Oxidation-reduction potential and flavor studies on milk from individual cows.

until 30 hours after milking, the first readings are comparable with the second readings on the milk used in a subsequent phase of this work.

The oxidation-reduction potential trend and the flavor results are shown in Figure 2. The points on the curves marked with "X" indicate where definite oxidized flavor development was first observed. The absence of any oxidized flavor is designated by the symbol "−." The number of "+" symbols indicates the degree of oxidized flavor which had developed in the samples at the end of the 125 hour storage period. A single "+" would indicate only a slight flavor and "++++" is used to show pronounced oxidized flavor.

It appears from the data that the absolute value of the oxidation-reduction potential of unmixed milk, pasteurized in glass, has no relation to the degree of oxidized flavor which develops.

THE EFFECT OF COPPER ON THE OXIDATION-REDUCTION POTENTIAL

Figure 3 shows the effect of copper sulfate added at the rates of 0.25, 0.50 and 1.0 p.p.m. copper on the oxidation-reduction potential of 50 per cent cream. Milk behaves similarly when treated in this way. The results confirm the work of Tracy, Ramsey and Ruehe (13) and Thurston (12) on the effect of copper on the oxidation-reduction potential of milk.

The increase in potential effected by copper is not proportional to the amount of the metal ion. This is especially true when the copper concen-
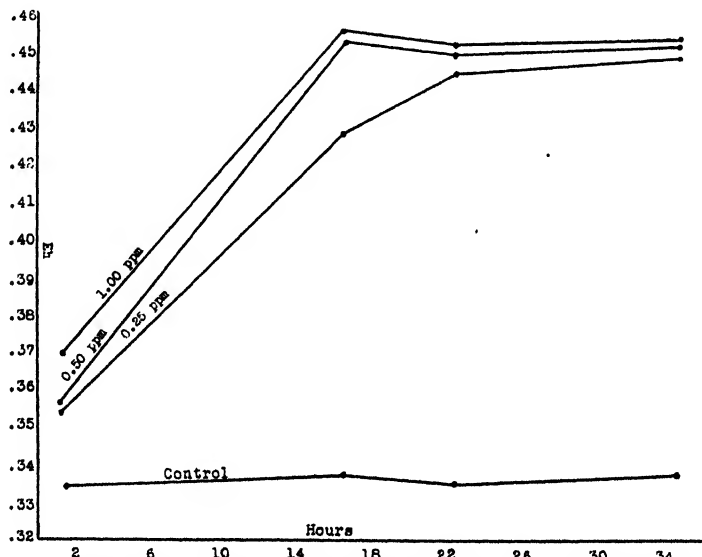
FIG. 3.   The effect of copper on the oxidation-reduction potential of 50% cream stored at 4.5° C.

tration exceeds 0.5 p.p.m. The increase of over 0.1 Eh on the addition of 0.25 p.p.m. copper to the cream shows the extreme sensitivity of the oxidation-reduction potential system to amounts of copper comparable with those dissolved from plant equipment.

STUDIES ON MIXED MILK

The following data are the results of an experiment carried out at a large retail milk plant over a period of 16 months, beginning November 15, 1934, and ending March 20, 1936.

During the period from the beginning of this experiment to November 7, 1935, the hot pasteurized milk was pumped from the glass enamel pasteurizers to an internal tubular cooler. The conductor pipes from the pasteurizers carrying the hot milk to the cooler were made of tinned copper, as were also the tubes of the cooler. These pipes were old and worn and large areas of bare copper were exposed to the hot milk. During pasteurization the milk was in contact with a bare copper thermometer stem as well as a 5 foot length of 2″ bare copper pipe used as part of the discharge line.

During the winter the bottled milk of this plant consistently developed oxidized flavor. With the coming of the summer months the flavor became less pronounced, but would recur when pasture season was over. Twice a month, as regularly as possible, a sample of milk representing one lot was taken at three points in the system. These samples were: (1) Raw mixed milk from a large storage tank. (2) Pasteurized milk from the pasteurizer, (3) Bottled milk.

The first oxidation-reduction potential determinations on each of these samples were made not later than three hours from the time of sampling. Two more readings were taken after 24 and 48 hours. The milk was tasted for evidence of oxidized flavor immediately after the last potential determination was made.

In November, 1935, twelve months after the experiment was begun, the internal tubular cooler was replaced by a new tinned copper surface cooler. At the same time a gravity flow system was arranged for, which eliminated the bronze pump in the hot milk line. The worn conductor pipes were replaced, and the bare discharge pipes removed from the pasteurizers. All thermometer stems were retinned. Samples were taken as usual.

The experiment is divided into three periods. The first, from November 16, 1934, to May 14, 1935, covers the "dry feed" or winter period. The second, from June 4th to November 2nd, 1935, is the period during the greater part of which the cows were on green feed. It was during these two periods that the bare copper condition existed at the plant. The third period, from November 7, 1935, to March 20, 1936, is the second winter period. At the beginning of this period the bare copper was eliminated at the plant.

The oxidation potential and flavor data are shown in Figures 4, 5 and 6. The points plotted on the curves represent the average Eh of all the samples taken at the indicated place during a given period. The three readings, 24 hours apart, show the general trend of the oxidation-reduction potentials of the milk from the different points during the three periods.
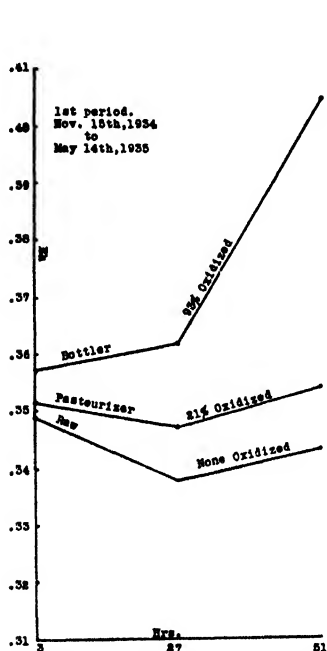
Fig. 4. Oxidation-Reduction Potentials And Flavor Of Milk During The Period From Nov.15,1934 to May 14,1935.
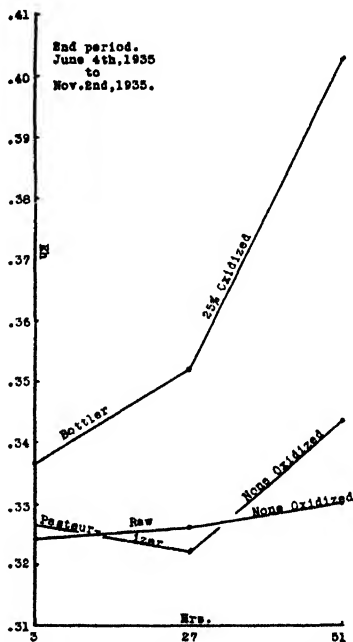
Fig. 5. Oxidation-Reduction Potentials and Flavor of Milk During The Period From June 4th, 1935 to November 2, 1935.

From Figure 4 it is evident that the flavor of mixed, processed winter milk is directly related to oxidation-reduction potentials. Of the samples from the pasteurizer, which had potentials slightly higher than the raw milk, 21 per cent developed oxidized flavor, while the much higher potentials in the samples from the bottler resulted in 93 per cent of these becoming oxidized.

The decreased susceptibility of the milk to oxidized flavor development in summer is shown in Figure 5. Of the samples from the raw supply and from the pasteurizer, none became oxidized. Only 25 per cent of the samples from the bottler became oxidized during the summer, despite the fact that the potentials were practically as high as during the winter.

Figure 6 shows the data for the third period. The installation of the new equipment at the beginning of this period, with elimination of the exposed copper, resulted in an immediate sharp drop in the potential of the

bottled milk, amounting to an average of 0.04 volt in the 48-hour-old milk. This drop in potential was accompanied by a corresponding decrease in oxidized flavor development, as compared with the previous winter. Only one sample, (14 per cent), of bottled milk became oxidized in this period, and this lot of milk was abnormal in that it showed the flavor in both raw and pasteurized samples as well as in the bottled milk. This was the only case of oxidized flavor in raw milk ever observed in this particular plant.

Figure 6. Oxidation-Reduction Potentials and Flavor of Milk During the Period From Nov. 7, 1935 to March 20, 1936.

Figure 7. Oxidation Potentials of Raw and of Pasteurized Bottled Milk Over the Period November 1934 to April 1936.
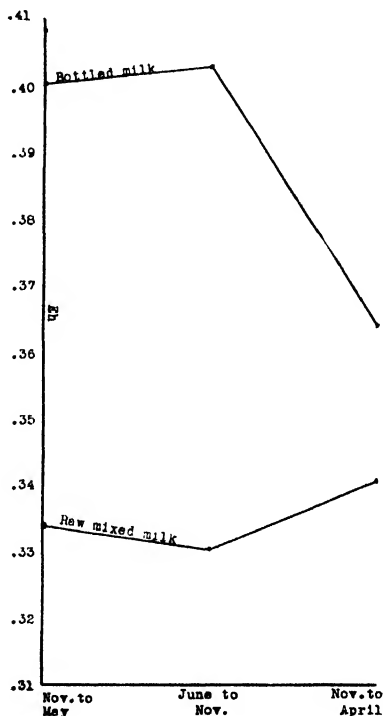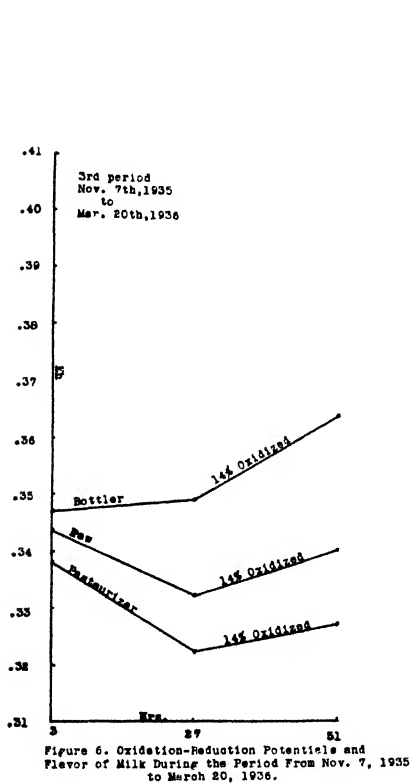
In Figure 7 the average Eh of the 48-hour-old raw milk for the three periods is plotted. There is also plotted the average Eh of the 48-hour-old bottled milk. This shows clearly that the copper dissolved in the milk from the equipment throughout the first two periods caused the potential of the bottled milk to be high, while the potential was much lower during the third period, after the exposed copper had been eliminated.

The graphs presented here contain no data having any bearing on the effect of light or of the structure of the fat on oxidized flavor development. The oxidation-reduction potentials do offer a very reasonable explanation of

the effect of copper in catalyzing oxidized flavor development. Apparently copper produces the flavor in winter milk by raising the potential to a point sufficiently high so that some milk constituent is affected. In the summer season this same potential is not high enough to cause flavor changes. In these experiments bacteria could not have been responsible for the summer protection, since the bacteria count in the pasteurized milk was not high enough to keep the potential down, although it is usually thought that bacteria protect against flavor changes by producing a reducing potential. Whether the failure of the high potentials to bring about flavor changes during the summer was due to absence of oleinase, or to the presence of an antioxidant, or to a change in the structure of the milk constituent responsible, cannot be determined from these data.

The data on the samples of milk from the Cornell Herd show that oxidized flavor can occur in the milk from individual cows without any apparent relationship to oxidation-reduction potentials. Guthrie and Brueckner (5) were able to retard or prevent oxidized flavor development in similar samples by high-temperature pasteurization, which tends to support the theory of Kende (8) that oleinase is the catalyst. If this is the case, then the mechanism of oxidation by oleinase does not involve the oxidation-reduction potential, and is therefore quite different from the mechanism of copper catalysis.

CONCLUSIONS

1. The development of oxidized flavors in milk by the addition of copper is due to or accompanied by an increase of the oxidation-reduction potential of the milk to a point sufficiently high to bring about a change in some milk constituent.

2. Summer milk is able to resist the development of oxidized flavors even in the presence of a high oxidation-reduction potential.

3. The decreased susceptibility of summer milk to oxidized flavor development does not appear to be due to bacteria.

4. It seems probable that mixed milk from a large number of herds will rarely develop oxidized flavor unless it is contaminated with copper or some other agent that will raise the oxidation-reduction potential.

5. There is no relationship between oxidized flavors and oxidation-reduction potentials of the milk of individual cows. Oxidized flavors in such samples can develop when the oxidation-reduction potential is very low.

6. Since the evidence in the literature seems to indicate that oxidized flavor in milk from individual cows is due to oleinase, the data presented here indicate that the mechanism of oxidation catalysis by oleinase is entirely different from the mechanism of the catalysis by copper, since the former does not involve high oxidation-reduction potentials, while the latter does.

7. Oxidation-reduction potential measurements afford a very delicate means of determining the source of copper contamination in a milk plant.

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A NOTE ON FEEDING VITAMIN A AND D CONCENTRATE IN COD–LIVER OIL TO CALVES

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For many years the unthrifty condition of dairy calves from 3 to 10 months of age at the New York Experiment Station and on farms of many good dairymen has been often observed. This unthrifty condition is shown by roughness of hide and hair, lack of alertness, and a tendency to chew wood. Consequently recent advertising and some research stating that dairy calves need a vitamin A and D supplement was welcomed, and a feeding trial was inaugurated to establish the effect of fortified cod-liver oil on the growth and health of calves under conditions of feeding regularly used at the New York Agricultural Experiment Station at Geneva.

It has been shown by several investigators, as summarized by Morrison,[1] that "vitamins A and D are of great importance in raising dairy cattle, for they often suffer from deficiencies of these vitamins." Nevertheless, "when calves are fed the usual type of satisfactory ration, including plenty of good hay, there is no need to add a vitamin A or D supplement." It was thought that the Experiment Station Jerseys were fed a good ration yet the calves in common with many other young calves, were not in the most thrifty condition.

PLAN OF EXPERIMENT

For the purpose of providing an ample supply of good hay, racks were constructed in each calf pen and alfalfa hay of average quality was before the calves at all times. The hay was somewhat coarse and never a bright green yet little of it was all brown in color.

The calves were fed mother's milk for 2 days. For 2 months they were fed pasteurized milk and skimmilk mixed in equal parts at the dairy, the mixture containing about 2.5 per cent milk fat. This milk was produced by 24 Jerseys and 7 Holsteins fed alfalfa hay, corn silage, and an 18 per cent protein grain ration consisting of corn 400, oats 300, linseed oil meal 400, distillers' grains 300, bran 570, salt 10, and steamed bone-meal 20 pounds. From 2¼ to 6 months of age pasteurized skimmilk was fed. All milk was fed twice daily in quantities determined by age and breed. The Jersey calves secured a maximum of 3 quarts per feed of milk-skimmilk and a maximum of 4 quarts of skimmilk per feed, the Holsteins receiving 50 per cent more. From 3

months to 6 months of age the calves had access to water once daily, thereafter twice daily.

Grain feeding began at 2 weeks of age and after the calves were 3 months old the grain was raised to a maximum of 4 pounds per day as rapidly as the calves would consume it.This usually occurred at 6 to 7 months of age. The grain ration consisted of the 18 per cent dairy-cow feed mixed in equal parts by weight with coarsely ground oats.

Four of the calves received no cod-liver oil supplement, the other four receiving vitamin A and D concentrate in cod-liver oil, Nopco XX,* in the following quantities. To each feeding of milk one cc. was added for the first month and for the next five months 2.5 cc. were added. From one to six months of age each cod-liver oil calf received 5 cc. daily in the milk. In addition, these calves also ate grain to which 0.25 per cent of cod-liver oil concentrate had ben added or a maximum of 4.5 cc. from the grain, this maximum always being secured after conclusion of feeding skimmilk.

The two lots of calves, each lot consisting of three Jersey heifers and one Holstein heifer, were weighed weekly and their appearance carefully observed.

TABLE 1

Influence of cod-liver oil concentrate on rate of growth of dairy calves as measured by average weight in pounds

AGE IN WEEKS	WEIGHT OF CALVES		AGE IN WEEKS	WEIGHT OF CALVES	
	Regular feed group	Cod-liver oil group		Regular feed group	Cod-liver oil group
0	63.5	63.5	21	240.5	255.5
1	65.0	67.2	22	254.0	267.7
2	70.5	73.2	23	264.7	279.2
3	78.2	80.0	24	275.8	290.0
4	84.2	86.5	25	288.2	301.2
5	89.7	94.5	26	294.8	313.5
6	97.5	102.0	27	308.5	325.8
7	105.0	110.8	28	317.5	338.5
8	114.0	118.7	29	331.2	347.0
9	124.0	125.2	30	335.5	354.0
10	133.8	134.5	31	348.2	364.8
11	140.8	144.5	32	360.2	370.2
12	151.0	154.0	33	369.2	383.5
13	162.0	163.2	34	380.8	388.8
14	171.2	176.2	35	387.0	396.5
15	179.5	187.5	36	393.5	409.5
16	189.0	196.0	37	399.7	416.5
17	198.0	210.2	38	408.8	425.5
18	209.0	218.0	39	416.2	431.8
19	222.5	230.5	40	425.2	440.0
20	231.2	245.5			

* Nopco XX, vitamin A and D concentrate and cod-liver oil, as used in these experiments contained 2000 U.S.P. vitamin A units and 250 U.S.P. vitamin D units per gram.

RESULTS

The average weekly weights of the two lots of calves for 40 weeks are shown in Table 1. Fortunately, the average weights of the two lots were identical at birth. Thereafter the calves fed cod-liver oil weighed slightly more than the other calves and this difference persisted throughout the feeding trial. It is probable that no significance can be attached to these slight differences in weight.

Throughout the feeding trials several interested persons unsuccessfully tried to select the calves in each group. It was evident, however, that if there was a difference in the calves it was for the calves fed cod-liver oil concentrate to show a slightly smoother condition of skin and hair. Diarrhea or colds were not troublesome with any of the calves.

A very surprising and unexpected result was that all eight calves always appeared in excellent condition and never developed that unthrifty condition, as evidenced by rough hair, dull appearance, and the occasional chewing of wood which is so common in calves at 3 to 10 months of age. It is believed that the improved condition of the calves was due to the use of hay racks which greatly increased consumption of alfalfa hay, more than double that consumed when hay was fed twice daily on the floor of the pen.

CONCLUSIONS

When calves were fed rather liberal quantities of partially skimmed milk, skimmilk, all the good alfalfa hay they could consume, and a good grain ration, the feeding of vitamin A and D concentrate with cod-liver oil did not increase growth during a 40 week feeding trial. If there was any difference in general health it was in favor of the calves fed vitamin A and D supplement but such differences, if present, were slight.

The experiment indicated the necessity of good hay being available to the calves at all times to secure maximum growth and a thrifty condition of health even though skimmilk and grain were fed in liberal quantities.

American Dairy Science Association Announcements

COMMITTEES OF THE MANUFACTURING SECTION

Under the ruling made by this Section at the June, 1936, meetings of the American Dairy Science Association it becomes the duty of the retiring chairman to appoint the committees of the Manufacturing Section for the next ensuing year.

In accordance with his ruling the following committee appointments are respectfully submitted.

L. M. Thurston, Retiring Chairman, Manufacturing Section.

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WORLD'S DAIRY CONGRESS

The eleventh World's Dairy Congress will be held in Berlin from August 22 to 29, 1937, according to announcements from the executive offices of the Congress. On November 1 a total of 387 scientific papers had been submitted for reading before the Congress. The scientific papers are grouped into four main divisions, namely, Section 1, Milk Production and Tropical Dairying; Section 2, Milk Processing and Treatment; Section 3, Legislation, Marketing, and Education; and Section 4, Dairy Machinery, Buildings, and Transportation.

There will be an International Dairy Exposition in Berlin during the week of the Congress. The exhibits will include all kinds of dairy equipment and apparatus. An International Products Contest will be held in three major groups of products, butter, cheese, and condensed and dried milk products.

Those persons who wish information about the World's Dairy Congress, about presenting papers, about the products contest, or about any aspect of the Congress should correspond with the General Secretary, W. Clauss, World's Dairy Congress, Lindenstrasse 28, Berlin S W 68, Germany.

A COMPARISON OF TEN PRESUMPTIVE TEST MEDIA USED IN THE DETECTION OF THE ESCHERICHIA-AEROBACTER GROUP IN MILK*

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The importance and significance of the colon group of organisms in raw milk is a disputed question among milk sanitarians (1, 2). It is generally conceded, however, that the test for these organisms offers an added safety precaution in controlling the efficiency of pasteurization (3, 4). "Standard Methods of Milk Analysis" (5) has recently included a tentative procedure for the detection of the *Escherichia-Aerobacter* group of organisms in milk. It advocates the use of 2.0 per cent brilliant green lactose bile as the presumptive test medium. In England the Ministry of Health (6) recommends a combined colony and coliform count on samples of certified and Grade A pasteurized, Grade A tuberculin tested, and Grade A milk. It suggests the use of MacConkey's lactose peptone bile broth as a presumptive test medium, for the determination of colon group members. The question has often arisen since these two media were primarily developed for the detection of these organisms in water, whether they are the best presumptive test media for the detection of *Escherichia-Aerobacter* organisms in milk (7). This study was undertaken with the object of answering this inquiry.

PROCEDURE

Ten presumptive test media which have been proposed for use in the detection of the *Escherichia-Aerobacter* group of organisms in water and milk have been included in this study. The names of these media and the abbreviations employed in this paper to facilitate the presentation of tabular material are listed below:

1. Lactose broth—S.L. (8)
2. Buffered lactose broth—B.L. (9)
3. Brilliant green lactose bile broth 2.0%—B.G. (10)
4. Fuchsin lactose broth—F.L. (11)

5. Methylene blue-brom-cresol purple broth—M.B. (12)
6. Crystal violet lactose broth—C.V.L. (13)
7. Formate ricinoleate broth—F.R. (14)
8. Gentian violet lactose broth—G.V. (3)
9. MacConkey's peptone lactose bile broth—P.L.B. (15)
10. Trypaflavine broth—Tryp. (16)

The first seven media were obtained in dehydrated form from the Difco Laboratories. These media were specially prepared for the "Committee on Standard Methods of Water Analysis," and were verified as being up to specifications of their proponents.[1] The eighth medium is included because it was one of the first media recommended for the detection of *Escherichia-Aerobacter* members in milk. The remaining two media were included for comparison because of their general acceptance as presumptive test media in England and Germany. MacConkey's medium was made according to his formula (15) and trypaflavine broth after the directions of Ruhmekorf (16). Three dilutions, 1.0 cc., 0.1 cc. and 0.01 cc., of each milk sample were employed and five tubes of each medium were planted from each of the three dilutions. Dilutions were prepared by transferring eleven cubic centimeters from the lower dilution into 99 cc. of sterile distilled water. These inoculated tubes were incubated for 48 hours at 37° C., after which interval they were examined for gas production. One tube of each medium showing gas formation (the highest dilution) was separately carried through the confirmatory and completed tests according to "Standard Methods of Water Analysis" (8).

DATA

The results of planting sixty-six samples of raw and certified milk into ten presumptive test media for the purpose of detecting the *Escherichia-Aerobacter* group of organisms is shown in the table which follows.

Table 1 shows the actual number of milk samples in which *Escherichia-Aerobacter* organisms were found to be present when sixty-six milk samples were planted into the ten presumptive test media and followed by the usual confirmatory tests. The average number of doubtful and positive presumptive tests is approximately forty-three, whereas the average number of tests which on completion were positive was approximately twenty-eight. The third horizontal column shows the percentage of presumptive tests which were positive upon confirmation and gives some idea of the time, labor and materials wasted in confirming the presumptive evidence observed when certain of these media were employed. Three of these ten media, brilliant green lactose bile broth, fuchsin lactose broth and methylene blue-brom cresol purple broth showed the largest number, thirty-five, of positive com-

[1] The proponent of each medium was asked to make comparisons of his own and the dehydrated product prepared by the Difco Laboratories in order to ascertain that the dehydrated product met the proponents' specifications.

TABLE 1

The efficiency of ten presumptive test media in the detection of the Escherichia-Aerobacter group in sixty-six raw milk samples

	S L	B L.	B G.	F L	M B.	C.V L.	F.R.	P.L B.	TRYP.	G.V.*
Number of Doubtful and Positive Presumptive Tests	35	42	44	45	43	40	61	47	31	34
Number of Positive Completed Tests	24	24	35	35	35	25	32	29	23	17
Per cent of Doubtful & Positive Presumptive Tests which upon Completion were Positive	68.6	57.1	79.5	77.7	81.9	62.5	50.8	61.7	74.2	50.0
Per cent of all Samples Positive	36.3	36.3	53.0	53.0	53.0	37.9	48.5	43.9	34.5	36.2

* Only forty-seven samples were run on this medium.

pleted tests for the *Escherichia-Aerobacter* group of bacteria. In terms of percentage of all samples positive, each of these three media showed an efficiency of *fifty-three per cent* in the detection of the *Escherichia-Aerobacter* group of bacteria in milk. The remaining seven media were definitely less efficient in the detection of this group of bacteria when both the numbers of presumptive tests confirmed and the percentage of all samples positive were considered.

SIGNIFICANCE OF THE "MOST PROBABLE NUMBER" INDEX

The tentative procedure for the detection of the colon group of bacteria as outlined in the sixth edition of "Standard Methods of Milk Analysis" (5) also includes information relative to the convenience of enumerating the "Most Probable Number" (M.P.N.) of *Escherichia-Aerobacter* organisms per 100 cubic centimeters of milk. The question naturally arises since these presumptive test media were not developed essentially for the detection of the colon group of organisms in milk, to what extent in each of these presumptive test media was the M.P.N. value found a true measure of the "coli" density in these milk samples. The data obtained in this study offers an answer to this inquiry.

The data obtained in the "presumptive test" when these sixty-six milk samples were planted in multiple portions (5 tubes)[2] for each of the three dilutions employed, offered a comparison not only of the presence or absence

[2] It is realized that the accuracy of a computed M.P.N. value when multiple portions of only five tubes are used as recommended in "Standard Methods of Milk Analysis" (5) is open to criticism. It is believed, however, that this multiple number offers a basis of comparison for these ten media as they are commonly used in routine work.

of *Escherichia-Aerobacter* organisms in these milk samples but also showed the density of the colon group of bacteria. Assuming that the presumptive test medium which shows the largest number of positive presumptive tests followed by the greatest percentage confirmation to be the most efficient medium in the detection of *Escherichia-Aerobacter* members in milk, it was of interest to correlate the "coli" density as indicated by these M.P.N. values with the actual presence or absence of colon members as found by the results of confirmatory procedure. McCrady's tables as found in "Standard Methods of Milk Analysis" (5) were employed to obtain these M.P.N. values. The following table in condensed form shows the M.P.N. values obtained for each of the sixty-six milk samples on each of these ten presumptive test media.

Table 2 shows the M.P.N. values and their frequency occurrence when these sixty-six milk samples were planted into these ten presumptive test media. The first horizontal column shows the number of milk samples, using the different media, found to have no *Escherichia-Aerobacter* group members present in the three dilutions employed. Brilliant green lactose bile broth showed gas formation in all but twenty-two samples, while formate-ricinoleate broth and trypaflavine broth were the two extremes and showed gas formation in all but five and thirty-six of the sixty-six milk samples respectively. The average M.P.N. values for these media based on the number of samples showing gas formation in each medium is shown at the bottom of the table. These averages show that formate ricinoleate broth has the highest average "Most Probable Number" with ten colon or other gas forming bacteria per cubic centimeter of milk. Brilliant green lactose bile broth, buffered lactose broth and crystal violet lactose broth, lead the remaining media with values of 5.9, 5.3 and 4.6 organisms per cubic centimeter respectively, while the other media all have an average M.P.N. of less than four organisms per cubic centimeter.

To ascertain the accuracy of the presumption that these M.P.N. values were the result of gas production by *Escherichia-Aerobacter* members only, the first and third horizontal columns in table 1 should be examined. Those media such as formate ricinoleate broth, buffered lactose broth and crystal violet lactose broth which showed gas production in sixty-one, forty-two and forty milk samples respectively were found upon confirmatory procedure to contain members of the *Escherichia-Aerobacter* group in only fifty-one per cent of the formate ricinoleate tubes, fifty-seven per cent of the buffered lactose tubes and sixty-three per cent of the crystal violet lactose samples showing gas production. The high M.P.N. values shown for these media in table 2, therefore, does not indicate a greater ability to detect members of the *Escherichia-Aerobacter* group. A possible interpretation of this result is that these media showing high M.P.N. values with lower percentages of doubtful and positive presumptives confirmed, were fermented by bacteria

TABLE 2

The frequency occurrence of the most probable number of Escherichia-Aerobacter organisms in sixty-six milk samples in ten presumptive test media*

SIGNIFICANT NO.	M.P.N /CC.	S.L.	B.L.	B.G.	F.L.	M.B.	C.V.L.	F.R.	F.L.B	TRYP.	G.V.**
0–0–0	0	31	24	22	21	23	26	5	19	35	13
0–0–1 to 1–4–0	0.2 to 1.1	15	18	8	17	15	15	16	16	14	15
2–0–0 to 2–4–0	0.5 to 1.4	5	5	9	10	11	9	5	6	6	7
3–0–0 to 3–5–0	0.8 to 2.5	8	6	9	5	7	5	7	9	1	4
4–0–0 to 4–5–1	1.3 to 5.0	3	7	7	5	1	3	7	5	4	2
5–0–0 to 5–5–5	2.5 to 180.0+	4	6	11	8	9	8	26	11	6	6
Total Most Probable Number		100.1	223.9	260.0	168.7	171.4	182.3	611.7	109.4	36.9	98.8
Average Most Probable Number Per cc.		2.86	5.33	5.91	3.75	3.99	4.55	10.03	2.33	1.19	2.91

* This table has been condensed primarily to save space. A listing of the significant numbers separately would have necessitated a two-page table.

** Only forty-seven milk samples were run on this medium.

other than the *Escherichia-Aerobacter* group, or that the colon organisms
were eventually overgrown by other species of bacteria present in the milk.
Brilliant green lactose bile broth, fuchsin lactose broth and methylene blue-
brom cresol purple broth with lower M.P.N. values, showed gas production
in forty-four, forty-five and forty-three milk samples respectively.   The
subsequent confirmatory procedure indicated the presence of *Escherichia-
Aerobacter* members in eighty per cent of the brilliant green, seventy-eight
per cent of the fuchsin and eighty-two per cent of the methylene blue-brom
cresol purple samples showing gas production in the presumptive test.

ESCHERICHIA-AEROBACTER CULTURES ISOLATED

The 319 cultures obtained from well isolated colonies on eosine methy-
lene blue plates were found to contain 140 cultures of the *Escherichia-
Aerobacter* group.   These 140 cultures were tentatively determined to
belong to the genus by the production of gas in lactose broth, their gram-
negative property and their reaction combinations by the formation of indol,
and acetyl methyl-carbinol; growth in citrate medium and the methyl red
test.   They were then identified within the genus by using the necessary
tests for keying out the species in Bergey's (17) Manual.   Seventy-four
cultures or fifty-three per cent were found to belong in the genus *Escherichia*
and fifty-six or forty per cent in the genus *Aerobacter*.   The remaining ten
cultures comprising seven per cent of the total were intermediate cultures.
These percentages are slightly higher than those found by Yale (18) for
raw milk.

DISCUSSION

The question concerning the efficiency of brilliant green lactose bile broth
as well as other media used in the detection of the *Escherichia-Aerobacter*
group of organisms in milk is a pertinent one in view of the tentative inclu-
sion of a method in "Standard Methods of Milk Analysis" (5) for the detec-
tion of these organisms in milk and other dairy products.   In a fundamental
study (20, 21) the ability of small numbers of the *Escherichia-Aerobacter*
group to grow in various presumptive test media has been determined.
Brilliant green lactose bile was found to have a desirability rating of fifth
and fourth respectively.

Most of these presumptive test media were developed with respect to their
dye content, percentage of ox-bile or bile salts, etc., with the object of in-
hibiting certain organisms responsible for false presumptive tests in water
analysis.   The use of these presumptive test media for the detection of colon
organisms in milk with the expectation that the inhibiting agents present
will prevent false presumptive tests to the same degree that they do in water
bacteriology is an erroneous supposition, since it is well known that the
presence of organic matter, which in milk is present in the form of proteins,

carbohydrates and lipoids very likely greatly decreased the concentration of these inhibitory substances through adsorption. With little or no inhibiting ingredients active in these media their ability to act as selective media for the detection of *Escherichia-Aerobacter* members in milk appears doubtful and the resulting development of bacteria would depend on the initial numbers of the various species present, their growth rates, and other factors.

Brilliant green lactose bile broth as recommended by "Standard Methods of Milk Analysis" (1934) was found in this study to be one of the three most efficient media in the detection of *Escherichia-Aerobacter* organisms in milk. The writer did not find the high percentage of confirmations for brilliant green lactose bile as were obtained by McCrady and Archambault (19) even when more than one colony was chosen for confirmation. Mac-Conkey's broth and trypaflavine broth as recommended in England and Germany do not appear from this work to be especially efficient in the detection of the *Escherichia-Aerobacter* group of bacteria in milk.

The use of a liquid medium and of a multiple number of tubes of each dilution for the enumeration of small numbers of *Escherichia-Aerobacter* organisms in milk is believed to be more accurate than when a solid-liquefiable culture medium is used (19). The utilization of this multiple tube inoculation to determine the density of *Escherichia-Aerobacter* organisms in milk was shown to be an erroneous procedure in this study involving a thousand tubes of each medium, where it was found that certain of those media having the highest "Most Probable Number" index are apparently permitting the growth of organisms other than the *Escherichia-Aerobacter* group.

In view of the above findings (1) that the majority of these media were not developed for the detection of *Escherichia-Aerobacter* member in milk; (2) that certain of these presumptive test media are fermented with gas production by bacteria other than the colon group of organisms and (3) that brilliant green lactose bile broth is no more selective for the *Escherichia-Aerobacter* group of bacteria than two other presumptive test medium, the question arises—Do we possess an efficient presumptive test medium for the detection of the *Escherichia-Aerobacter* group of bacteria in milk? From the evidence obtained in these experiments the writer is inclined to believe we do not. In addition to those conditions mentioned above this belief is based on the findings that the three media found in this study to be superior in the detection of the *Escherichia-Aerobacter* group were often irregular in detecting colon organisms in the same sample. These three media also showed only eighty per cent confirmation of doubtful and positive presumptive tests. This indicates that even with these better media there were still twenty per cent of false presumptive tests. If the confirmation of every fifth doubtful presumptive test is going to involve a waste of time and materials it appears to the writer that there is an opportunity for the develop-

ment of a more efficient presumptive test medium for detecting this group of bacteria in milk.

The writer wishes to thank Mr. T. Polansky for his assistance in the course of this work.

SUMMARY

1. Brilliant green lactose bile broth, fuchsin lactose broth and methylene blue-brom cresol purple broth were found to be equally efficient in the detection of *Escherichia-Aerobacter* members in sixty-six raw milk samples.

2. The remaining seven media appear definitely less efficient in the detection of these organisms.

3. The use of the ''Most Probable Number'' index as a measure of the density of the *Escherichia-Aerobacter* group in milk was found to be very inaccurate when certain of these presumptive test media were employed.

4. The question is raised whether we possess a reliable presumptive test medium for the detection of these organisms in milk.

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MERCURIC CHLORIDE AS A PRESERVATIVE FOR MILK SAMPLES HELD FOR THE DETERMINATION OF LACTIC ACID

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Methods for the quantitative determination of lactic acid in dairy products and directions for preserving milk samples for such determinations, were recently published by Troy and Sharp (2) (3). It was stated that ''mercuric chloride in a concentration of about 0.2 to 0.5 per cent seems to be a satisfactory preservative for periods of a month or less if the milk is kept in the dark at 20° C. or below.''

A number of samples of milk received for lactic acid determination were found to increase slowly in lactic acid value upon holding. These samples contained a black deposit of reduced mercury. This experience caused us to reinvestigate the use of mercuric chloride as a preservative.

Aliquots of sweet and partially soured whole milk were preserved with different amounts of mercuric chloride. A black precipitate of reduced mercury formed if somewhat less than 0.5 per cent of mercuric chloride was added. The tendency of the mercuric chloride to reduce increased with the decrease in the amount added. The samples were held at ordinary laboratory temperatures in clear glass bottles in diffused daylight.

The lactic acid values obtained after various intervals of time are given in table 1. It is evident that 0.2 per cent of mercuric chloride represents the lower limit of concentration for preservation of samples for one month under these conditions, and that 0.5 per cent would allow a margin of safety. The presence of a dark precipitate of reduced mercury may be used as an indication that insufficient mercuric chloride was added for the optimum preservation of the sample for the lactic acid determination.

No bacteria were found in the samples when they were plated at the end of 12 weeks by Pauline Stark of the department of bacteriology. At the end of the experiments reported in tables 1 and 2 the samples were streaked in duplicate on nutrient agar and on milk agar slopes. The presence of microorganisms was evidenced in the samples containing 0.02 and 0.05 per cent of mercuric chloride, but not in any of the samples containing 0.2 per cent or more.

After holding for long periods of time blue filtrates were obtained from the precipitation with copper sulfate and lime suspension in the clarification of the milk for the determination of lactic acid. The blueness of the filtrate was inversely proportional to the concentration of mercuric chloride. Corresponding with the blueness of the filtrates, proportionately greater diffi-

TABLE 1

Effect of increasing amounts of mercuric chloride in preserving milk for the determination of lactic acid

MERCURIC CHLORIDE	LACTIC ACID VALUES AFTER HOLDING							PROTEIN NOT PRECIPITATED BY Cu(OH)₂ AFTER HOLDING			MICROORGANISMS	
	0	2 weeks	4 weeks	6 weeks	12 weeks	18 weeks	28 weeks	12 weeks	18 weeks	28 weeks	12 weeks	24 weeks
%	%	%	%	%	%	%	%	%	%	%		
					Sweet whole milk—unheated							
.05	.000	.000	.003	.010	.014	.024	—	.35	.95	—	absent	present
.20	.000	.000	.000	.008	.011	.011	.021	.17	.24	.30	absent	absent
.50	.000	.000	.000	.001	.001	.002	.013	.16	.22	.23	absent	absent
2.00	.000	.000	.000	.000	.001	.001	.002	.10	.10	.16	absent	absent
					Partially soured whole milk—unheated							
.05	.141	.142	.149	.158	.166	.166	—	.95	1.97	—	absent	present
.20	.141	.141	.144	.153	.158	.165	.204	.51	.66	1.13	absent	absent
.50	.141	.140	.142	.146	.150	.160	.181	.23	.31	.50	absent	absent
2.00	.141	.140	.140	.150	.148	.158	.178	.14	.18	.21	absent	absent

culty with fading endpoints in the acetaldehyde titration was encountered. In using $Cu(OH)_2$ for protein precipitation as recommended in the method previously (2) described, it was found that blue filtrates indicated the presence of protein split products. The nitrogen content of the filtrates of the samples represented in table 1 was found to increase progressively with time and with a decrease in mercuric chloride. The increase in lactic acid value is related to the increase in protein hydrolysis. Probably little or no increase in lactic acid occurred, the apparent increase being due to the interference of protein split products which were not removed by the $Cu(OH)_2$.

The results in table 1 show that protein hydrolysis was more marked in the partially soured samples. Since the milk was not heated, the hydrolysis might be due to proteolytic enzymes. In addition to the natural proteolytic enzymes of the milk, the partially soured samples contained enzymes derived from the bacteria. Increasing amounts of mercuric chloride exert a progressively retarding effect on proteolytic enzymes.

Table 2 presents the results obtained when the experiment was repeated, but in this case each sample was divided into two parts and one part was heated for 5 minutes at 80° C., to destroy the enzyme activity of the milk and the bacteria. At the end of 4 weeks the soluble protein had increased more in the unheated partially soured samples than in the unheated sweet samples. By the end of 12 weeks a definite increase had taken place in all samples. The increase in soluble protein may be attributed to enzyme action and advantage may be taken of mercuric chloride as a preservative for studying proteolytic enzyme activity in milk under various conditions. The proteolysis which occurred in the heated samples indicates that at least some hydrolysis took place without the aid of enzymes and therefore an alternate explanation is possible.

Proteins are slowly denaturized and hydrolized on long standing in contact with water, particularly if they are not near their isoelectric points. Hydrolysis is more rapid if the protein is in solution. Carpenter (1) has very clearly shown the effect of time, temperature and pH on the hydrolysis of casein. Thus the hydrolysis shown in tables 1 and 2 may not be due to enzymes, but to the natural hydrolytic action of the water. Heavy metal salts inactivate many enzymes and may have inactivated the proteolytic enzymes in this case. The rate of natural hydrolysis would be expected to be inversely related to the insolubilizing effect of heat and increasing concentration of mercuric chloride. The preliminary slight proteolytic action of the bacteria in the partially soured samples might prepare the proteins for a more rapid natural hydrolysis. The marked proteolysis of the unheated samples containing the smaller amounts of mercuric chloride was probably due to both enzymes and the natural hydrolytic effect of the water.

The cans of milk which were rejected one morning at the receiving platform of a country milk plant because of undesirable odors were sampled.

TABLE 2

Effect of increasing amounts of mercuric chloride on the preservation of raw and heated milk for the determination of lactic acid

TREAT-MENT	AMOUNT OF HgCl₂ ADDED	LACTIC ACID VALUE AFTER HOLDING			PROTEIN NOT PRECIPITATED BY Cu(OH)₂ AFTER HOLDING			MICRO-ORGANISMS 12 weeks
		0	4 weeks	12 weeks	0	4 weeks	12 weeks	
	%	%	%	%	%	%	%	
Sweet skimmilk								
Raw	0.02	.000	.006	Mold	.13	.18	Mold	Present
Heated	0.02	.000	.001	Mold	.11	.17	Mold	Present
Raw	0.05	.000	.002	Mold	.11	.15	Mold	Present
Heated	0.05	.000	.002	.002	.11	.11	.15	Present
Raw	0.20	.000	.001	.003	.11	.13	.22	Absent
Heated	0.20	.000	.002	.001	.11	.11	.15	Absent
Raw	0.50	.000	.000	.003	.11	.12	.16	Absent
Heated	0.50	.000	.002	.001	.11	.10	.17	Absent
Raw	1.00	.000	.000	.003	.11	.13	.18	Absent
Heated	1.00	.000	.000	.000	.11	.11	.15	Absent
Partially soured skimmilk—Sample No. I								
Raw	0.02	.060	*.500	Mold	.14	.53	Mold	Present
Heated	0.02	.064	*.152	.611	.14	.12	.41	Present
Raw	0.05	.060	.069	Mold	.15	.33	.18	Present
Heated	0.05	.064	.068	.436	.12	.10	.16	Present
Raw	0.20	.060	.063	.074	.12	.18	.15	Absent
Heated	0.20	.064	.065	.070	.12	.10	.17	Absent
Raw	0.50	.060	.061	.073	.12	.11	.18	Absent
Heated	0.50	.064	.065	.081	.12	.10	.18	Absent
Raw	1.00	.060	.062	.068	.12	.11	.17	Absent
Heated	1.00	.064	.060	.070	.12	.11	.19	Absent
Partially soured skimmilk—Sample No. II								
Raw	0.02	.102	.103	Mold	.24	Mold	Mold	Present
Heated	0.02	.104	.111	Mold	.14	.14	Mold	Present
Raw	0.05	.102	.114	.136	.22	.64	1.25	Present
Heated	0.05	.104	.110	.116	.13	.14	.16	Present
Raw	0.20	.102	.107	.119	.12	.29	.65	Absent
Heated	0.20	.104	.107	.114	.12	.11	.17	Absent
Raw	0.50	.102	.104	.117	.12	.16	.28	Absent
Heated	0.50	.104	.107	.113	.12	.11	.17	Absent
Raw	1.00	.102	.102	.106	.12	.14	.25	Absent
Heated	1.00	.104	.106	.110	.12	.12	.16	Absent

* Ropy.

Pint samples were taken and two mercuric chloride tablets were added to each pint. Even if the tablets were pure mercuric chloride, the concentration of preservative was less than 0.2 per cent. The milk was not heated. Lactic acid determinations were made at the end of 2 and 9 days. The

results are presented in table 3. The endpoints in the acetaldehyde titration were not sharp in all cases. The odor of butyric acid could be detected in some of the samples and others contained large numbers of proteolytic bacteria. In this case an alteration in the sample occurred during a relatively short period of holding. This effect must have been due to enzymes.

TABLE 3

Lactic acid values of samples of raw milk taken from cans which were rejected at the receiving platform. Two mercuric chloride tablets per pint were added at once as a preservative

SAMPLE NUMBER	LACTIC ACID VALUE AFTER HOLDING THE PRESERVED SAMPLE FOR		
	2 days	9 days	Increase
	%	%	%
1	.001	.003	.002
2	.004	.010	.006
3	.004	.005	.001
4	.002	.009	.007
5	.002	.007	.005
6	.005	.011	.006
7	.009	.014	.005
8	.005	.009	.004
9	.010	.015	.005
10	.006	.011	.005
11	.004	.008	.004
12	.003	.012	.009
13	.001	.004	.003

The results presented in table 3 show that every one of the samples rejected because of an undesirable odor was either slightly sour or was abnormal in some other respect, as shown by the determination of lactic acid.

SUMMARY

Milk samples can be preserved satisfactorily for lactic acid determination up to one month when treated as follows:

Add not less than 0.5 per cent of mercuric chloride, then heat the sample to 80° C., for 5 minutes, cool and hold at 20° C., or lower, preferably in the dark.

The possibility of the use of small amounts of mercuric chloride as a preservative for studying the proteolytic action of milk is discussed.

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VARIANTS OF STREPTOCOCCUS LACTIS WHICH DO NOT FERMENT LACTOSE

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The literature abounds with instances in which apparently pure bacterial strains show variation in the fermentation of sugars. In the fermentation reactions of any one species, there are frequently several test substances which may or may not be fermented. In many groups, however, the fermentation of some test substance is considered so characteristic that deviation from the usual reaction is used as a basis for a new species.

More than thirty years ago, Neisser (1) reported the occurrence of an organism belonging to the coli-aerogenes group which failed to ferment lactose. On lactose agar plates, however, this strain gave rise to secondary colonies which had the power of fermenting this sugar. Since that time many similar cases have been noted.

In the case of *Streptococcus lactis*, the fermentation of lactose and the souring of milk have been considered such basic characteristics that a strain which lacked these properties would not have been recognized as belonging to the group. However, Orla-Jensen (2) states that ". . . many strains prefer maltose to lactose. . . ." As *S. lactis* is usually isolated from milk or milk products, it seems logical to expect that non-lactose-fermenting strains, if present, would not grow so rapidly as the fermenting strains and hence would not be so readily isolated. *A priori*, there would appear to be no logical reason why non-lactose-fermenting variants of this species should not exist.

In a study of strains of *S. lactis* isolated from milk, four cultures were encountered which failed to curdle milk. Tests showed that they produced only a negligible amount of acid in milk; 0.03 to 0.04 per cent, calculated as lactic acid. At first it was thought that they were weakened strains, but an active fermentation in glucose broth, with a final limiting acidity of pH 4.0 to 4.2, indicated that this was not the case.

THE IDENTITY OF STREPTOCOCCUS LACTIS

Although *Streptococcus lactis* has long been known and extensively studied, its exact identity was not clarified until comparatively recent years. Among more observing bacteriologists, the complete reduction of litmus before curdling in milk cultures was long looked upon as an especially characteristic property of the organism (Hastings, 3). Esten (4), however, was misled in an important investigation by assuming that this typical action on litmus milk was not shared by any other streptococcus. Andrews and

Horder (5) had previously shown the strong reducing action of *S. fecalis* on neutral red, a substance more difficult to reduce, and MacCallum and Hastings (6), as early as 1899, had shown the same action in litmus milk cultures to be particularly characteristic of that gelatin-liquefying streptococcus which now goes under the name of *S. zymogenes.* It is now known that in addition to *S. lactis* and its relatives in the "lactic group," the ability to reduce litmus in milk prior to curdling is also a characteristic of the so-called "enterococcus group" consisting of *S. fecalis, S. zymogenes,* and *S. liquefaciens.*

The lactic acid streptococcus was first clearly defined by Sherman and Albus (7) who showed that, in addition to other characteristics, *S. lactis* has a minimum growth temperature below 10° C. and a maximum temperature for growth at about 43° C., and that these properties are correlated with the characteristic action in litmus milk. So far as present information extends, no streptococcus outside of the lactic group has this combination of characteristics. They also showed that *S. lactis* is not inhibited by dilute solutions of methylene blue, and gives the following fermentation reactions: the hexose sugars and lactose are fermented; raffinose, inulin, starch, and glycerol are not fermented; maltose, sucrose, mannitol, and salicin may or may not be fermented, though maltose usually is fermented while sucrose more often is not. Orla-Jensen (2) has shown that variable fermentation results are also obtained, within the species, on arabinose and xylose. It is also now known that typical cultures of *S. lactis* produce ammonia from peptone, but do not hydrolyze starch, as revealed by the starch agar plate technique (8, 9). Moreover, it has recently been shown that, in addition to their respective maximum temperatures of growth, *S. lactis* may be differentiated from *S. fecalis* on the basis of other tests (10).

There are, therefore, ample grounds on which to base a positive identification of *S. lactis,* even though the particular strain is a variant in some otherwise especially characteristic property.

THE CHARACTERISTICS OF THE VARIANT CULTURES

Four cultures which failed to ferment lactose were identified as *Streptococcus lactis* on the basis of the following combination of characteristics.

Growth took place at 10° C. and at 40° C., but no growth occurred at 45° C. In litmus milk cultures the litmus was completely reduced, but acid was not produced and the milk was not curdled. In litmus milk to which 2 per cent glucose was added, a reaction typical of *S. lactis* was obtained; the milk was rapidly acidulated and curdled, and the litmus was completely reduced prior to the curdling of the milk.

No growth occurred in broth containing 6 per cent sodium chloride; growth was not inhibited by medicinal methylene blue in a concentration of one part in 1,000 parts of skimmed milk; ammonia was produced in four

per cent peptone; carbon dioxide was not produced from glucose; starch was not hydrolyzed.

Glucose, fructose, maltose, and salicin were fermented; arabinose, lactose, raffinose, inulin, and glycerol were not fermented. The only variations obtained were with xylose, sucrose and mannitol, which are commonly known to represent variable characters within the species. Based on these three substances, there were two strains: one which failed to ferment xylose but fermented sucrose and mannitol, and another which fermented xylose but failed to ferment sucrose and mannitol.

In the light of present knowledge, it is permissible to consider these cultures definitely identified as members of the *S lactis* group.

THE TAXONOMIC STATUS OF THE VARIANT

We recommend, for the present at least, that this variant be recognized only as such, within the species of *Streptococcus lactis*. Of course, if one were to follow the extreme differentiation, based on fermentation tests, advocated by Orla-Jensen and Hansen (11), this variant would have to be considered a new species. However, the absurdities to which such a policy would inevitably lead have previously been pointed out (9). In a species which shows so many other variations with the fermentation tests, there would appear to be no sound grounds for creating a new species on the basis of the non-fermentation of lactose. Strains which vary on this sugar are known in other species of bacteria, and, indeed, Rogers (12) has shown the soundness and logic of recognizing non-lactose-fermenting strains of *Bacterium aerogenes*.

When bacteriologists are finally driven to the realization that dependence must be put upon more basic characteristics, and a wider assortment of tests, the fermentation reactions will take their still important but secondary place in bacterial taxonomy.

That our views on this matter appear to be correct, so far as the present case is concerned, is indicated by the fact that after cultivation in milk for ten months, one strain is now able feebly to ferment lactose, and curdles milk after two weeks.

SUMMARY

Four cultures of *Streptococcus lactis* which did not ferment lactose were isolated from milk. These cultures were shown to agree with typical *S. lactis* strains in all other respects.

It is believed that these cultures represent naturally occurring variants of *S. lactis*, and this view appears to be borne out by the fact that one strain, after cultivation in milk for ten months, is gradually acquiring the ability to ferment lactose.

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A FURTHER STUDY OF THE FACTOR IN SOYBEANS AFFECTING THE VITAMIN A VALUE OF BUTTER[1]

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In previous publications (1, 2, 3), it had been shown that whenever soybeans were introduced into rations of dairy cows, either through soybean hay or as part of the grain rations, the soybeans had a suppressing action on the formation of vitamin A in butter. The possibility that the factor responsible for the suppression of the vitamin A value in milk fat might be the same as that responsible for the repressed growth of rats and hogs (4, 5, 6) was eliminated, when it was found that roasting the soybeans, a treatment which improves the nutritive value of soybeans for growth (4), did not modify the factor responsible for the lowered vitamin A value of butter (2).

Furthermore, the stability of this factor to the heat of the roasting process (2) and to the temperatures used in the drying of soybean hay with the mechanical drier (3), indicates that it is not thermo-labile.

Since this factor is found in the beans, experiments were conducted for the purpose of determining what component part or parts of the bean are responsible for this action. There existed the possibility that on extraction of the oil from the beans, this factor might be found to be associated entirely with the oil, or that it might be retained by the meal. If the factor was not removed from the bean by the extraction of the oil, there still existed the possibility that it might be eliminated by further treatment with various solvents.

EXPERIMENTAL

The soybeans used in these experiments were secured from the same source. Some were treated in a commercial soybean plant and others subjected to various treatments in the chemical laboratory. The following products were prepared and used in the feeding trials:

1. Soybeans. These were raw and untreated.
2. Soybean Oil Meal (Expeller Process). This was prepared in a commercial soybean plant by the regular expeller process.
3. Soybean Oil (Expeller Process). This was the oil from the above meal.

4. Soybean Oil Meal (Solvent Method). This product was prepared by prolonged extraction of ground soybeans, first with ethyl ether and then with ethyl alcohol in a Lloyd's Extraction Apparatus.

5. Soybean Oil (Solvent Method). This oil was secured during the first step of the extraction process as described under No. 4, when the beans were extracted with ethyl ether.

6. Alcoholic Extract. This product was secured during the second step of the extraction process as described under No. 4, when ethyl alcohol was used as the solvent.

In addition to these soybean products, linseed oil meal and linseed oil were used in some of the rations of the feeding trials.

Four Guernsey cows divided into two groups of two cows each were used in the feeding experiments. All cows were in the early stages of lactation at the beginning of the feeding trials and continued throughout the tests in a fairly uniform daily milk production. All cows received alfalfa hay, corn silage and a basal grain mixture of 400 pounds ground white corn and 200 pounds ground oats. The alfalfa hay furnished the principal source of vitamin A in the ration. The hay was of excellent quality and was fed in uniform amounts throughout the trials. The corn and oats mixture was modified by the addition of the various ingredients studied during the various feeding periods. Each feeding period was of 21 days duration. Group A received in addition to the basal ration the following ingredients added to the grain mixture in successive feeding periods: A-1, 100 pounds linseed oil meal; A-2, 100 pounds raw soybeans; A-3, 100 pounds soybean oil meal (expeller) and A-4, 100 pounds linseed oil meal plus 5 per cent linseed oil.
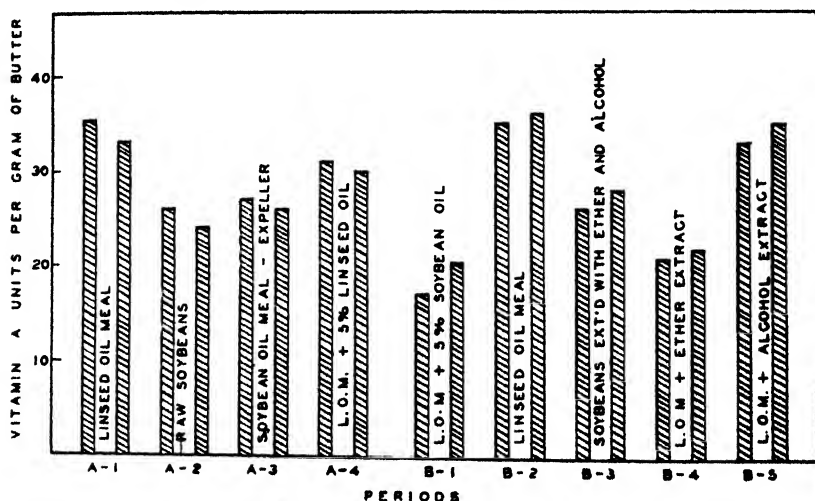
CHART I. Showing the effect of the vitamin A suppressing factor found in soybeans and its products upon the vitamin A value of butter.

The corn and oats mixture of Group B was modified as follows in successive feeding periods: B-1, 100 pounds linseed oil meal plus 5 per cent soybean oil; B-2, 100 pounds linseed oil meal; B-3, 100 pounds soybean oil meal (solvent process); B-4, 100 pounds linseed oil meal plus soybean oil from ether extraction from 100 pounds soybeans and B-5, 100 pounds linseed oil meal plus alcoholic extract from 100 pounds fat free soybean oil meal.

Representative samples of milk were collected from each cow at the end of each 21 day feeding period, the cream separated and churned into butter. Each butter sample was then subjected to biological assays for vitamin A, using the technique previously described (1).

The results of these assays are given in Chart I and table 1, the values being expressed in Sherman and Munsell (7) vitamin A units.

TABLE 1

Showing the rations fed the cows during each period and the vitamin A activity of the butterfat produced by cows fed the various supplements

PERIOD NO.	ROUGHAGE		GRAIN RATION			COW NO	VITAMIN A UNITS PER GRAM (BUTTER)
	Hay	Silage	White Corn	Oats	Supplements		
A1	Alfalfa	Corn	400 lbs.	200 lbs.	100 lbs. linseed oil meal (check)	514 / 438	35 / 33
A2	"	"	"	"	100 lbs. raw soybeans	514 / 438	26 / 24
A3	"	"	"	"	100 lbs. soybean oil meal (expeller)	514 / 438	27 / 26
A4	"	"	"	"	100 lbs. linseed oil meal plus 5 per cent linseed oil	514 / 438	31 / 30
B1	"	"	"	"	100 lbs. linseed oil meal plus 5 per cent soybean oil	513 / 439	17 / 20
B2	"	"	"	"	100 lbs. linseed oil meal (check)	513 / 439	35 / 36
B3	"	"	"	"	100 lbs. soybeans (extracted with ether and alcohol)	513 / 439	26 / 28
B4	"	"	"	"	100 lbs. linseed oil meal plus soybean oil from ether extraction from 100 lbs. soybeans	513 / 439	21 / 22
B5	"	"	"	"	100 lbs. linseed oil meal plus alcoholic extract from 100 lbs. soybeans	513 / 439	33 / 35

DISCUSSION

In these experiments, alfalfa hay was the chief source of vitamin A in the ration fed the cows. Since the amount of alfalfa fed each cow daily was

so regulated that the potential vitamin A values of the rations were the same in each lot and throughout the successive feeding periods, any difference in the vitamin A values of the butter could only be attributed to the effects of the various supplements in the grain mixtures.

From the results presented in Chart I it can be seen that butters made from the milk of cows fed the check ration (linseed oil meal) possessed high vitamin A values. The lower vitamin A value of the butter secured when raw soybeans were substituted for linseed oil meal in the grain ration of the cows shows the effect of the factor in soybeans responsible for the suppression of vitamin A activity of butter.

In studying the different fractions prepared from soybeans, it is interesting to note that on the removal of the oil either by the expeller process or by chemical solvents much of this factor followed the oil. When five per cent of the oil was added to the check ration, there was a marked suppression of the vitamin A value of the butter.

This suppressing action of the soybean oil might appear to be due to the oil itself. However, when the butters secured by feeding five per cent soybean oil are compared with those secured from feeding five per cent linseed oil, it becomes apparent that this effect is not produced by the presence of oil in the ration but rather by something in the soybean oil which apparently is not present in linseed oil.

Although a good portion of this factor is present in the soybean oil, the soybean oil meal (expeller process) contains significant amounts. Even after the complete removal of the oil by exhaustive extraction with ethyl ether followed by similar extraction with ethyl alcohol, this factor still remains in the soybean oil meal. This further indicates that the suppressing action is not due to the oil itself but to some other factor distributed in both the oil and the soybean oil meal.

When the alcohol extract, obtained by extraction with ethyl alcohol of the soybean oil meal which had been previously extracted with ether to remove the oil, was included in the rations of the cows, butter was obtained which possessed high vitamin A activity. Since the soybean oil meal still contained the suppressing factor, it becomes evident that this factor is not soluble in alcohol, or at least not extractable by alcohol after the removal of the oil.

From these studies on the interfering action of soybeans and soybean products on the formation of vitamin A in butter, it is apparent that there is a definite factor responsible for this action, which is stable to heat, insoluble in alcohol and found in the soybean seed, soybean oil and soybean oil meal.

SUMMARY

1. Further studies have been made of the vitamin A suppressing factor in soybeans which interferes with the transference of the vitamin A activity of the feed to the butterfat secreted by dairy cows.

2. This factor was found to be distributed in both the soybean oil and soybean oil meal secured by either the expeller process or by chemical solvents.

3. The suppressing action is not due to the presence of oil in the ration but to some factor in soybean oil in the bean.

4. Prolonged extraction of soybeans first with ethyl ether and then with ethyl alcohol failed to completely remove this factor.

5. The inability of alcohol to extract the factor from fat free soybean oil meal indicates that it is not soluble in ethyl alcohol.

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A SIMPLE PLANT METHOD OF ESTIMATING THE ALKALINE CONSTITUENTS OF WASHING POWDERS AND WASHING SOLUTIONS CONTAINING MIXED ALKALIES

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With the new developments in cleaning in the dairy industry and the great number of new cleaning powders on the market, each making astounding claims for their product, the dairy plant manager is greatly in need of a simple, rapid plant test by which he can determine the approximate ingredients of the various cleaners in order to evaluate their worth. Many plant operators use a mixture of two or more alkalies in the soaker compartment of their bottle washing machine. Some alkalies possess the ability of maintaining their strength in solution longer than others. Therefore in order to maintain a constant balance between the different alkalies it becomes necessary for the plant operator to be able to determine the amount of each alkali present at frequent intervals.

The most satisfactory method of determining the ingredients in a solution of mixed alkalies consists in titrating a sample of the alkali with standard acid to the phenolphthalein end point, taking the reading and continuing the titration to the methyl orange end point. The first titration minus the second is considered to represent the caustic soda portion. The methyl orange titration represents one half of the soda ash portion. When silicates or phosphates are present, a saturated solution of barium chloride is added and the phenolphthalein titration is considered as caustic soda, while the methyl orange titration is calculated as soda ash. This method will give correct results only when the solution contains only caustic soda and soda ash. When silicates are present they will largely be included in the caustic soda portion, while phosphates will be largely included in the soda ash portion. Myers (2) recommends the use of an additional indicator, trinitrobenzene, in the analysis of mixed alkalies, but we were unable to use this method, or any of the many other modifications, with any satisfaction when the alkali included either silicates or phosphates in the presence of soda ash and caustic soda. The alkalies most commonly used in dairy washing powders are caustic soda, soda ash, sodium meta silicate, and trisodium phosphate. Practically all dairy washing powders are made up of these alkalies, either singly or by combining them in various proportions. A detailed study was made of the four alkalies in view of finding a selective reaction or method of treatment which could be used to analyze each ingredient when in the presence of one or more of the others.

Figure 1 shows the approximate pH of solutions of each of the four alkalies from 0.1 to 4.0% concentration. A study of this chart will reveal
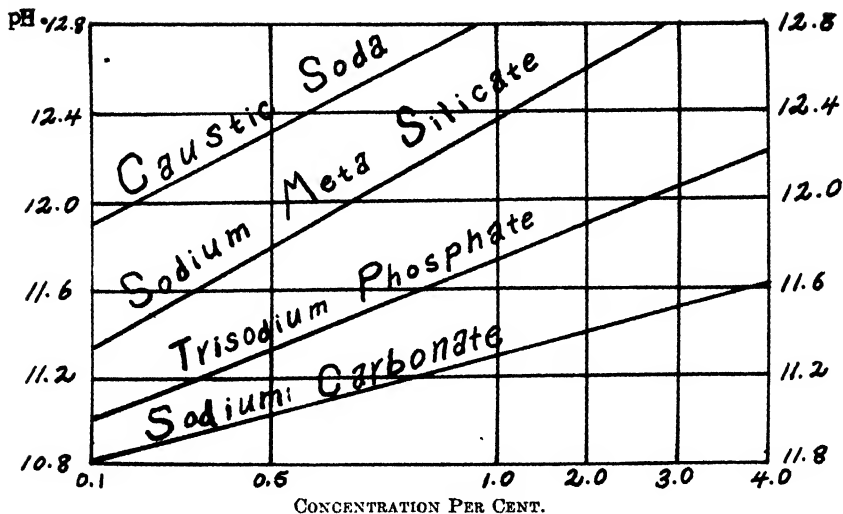
FIG. 1. THE APPROXIMATE pH OF SOLUTIONS OF CAUSTIC SODA, SODA ASH, TRISODIUM PHOSPHATE, AND SODIUM META SILICATE OF VARYING CONCENTRATIONS.*

that they can not be distinguished by the use of different indicators alone. The results of a detailed study of the alkalies is presented in table 1. The caustic soda is 100% active at the phenolphthalein end point, while sodium meta silicate is 93.5% active and soda ash is 50% active. It is usually considered that trisodium phosphate is one third active at the phenolphthalein end point, one third active at the methyl orange end point and one third inert at the methyl orange end point, however in this study the average of all the samples analyzed was 42.12% active at the phenolphthalein end point and all of the samples studied were close to this average, falling within the range of from 40 to 45%. The average for all the trisodium phosphate samples analyzed was 35.70% active from the phenolphthalein to the methyl orange end point. We considered this to be one third of the trisodium phosphate, and for plant analysis the error in considering it thus will be so small that it can be ignored. With the exception of trisodium phosphate, all the other alkalies were completely active at the methyl orange end point. The average for the trisodium phosphate samples being 22.18% inert at the methyl orange end point.

The first procedure was to find a method for determining caustic soda which would exclude all the other alkalies. An attempt was made to precipitate the sample with barium chloride and filter out all but the caustic soda portion. This will remove all the alkalies but a small portion of the sodium meta silicate, but this could not be completely removed by filtering

* From material presented by the Philadelphia Quartz Co.

through the finest filter paper. Sodium hydroxide is soluble in hot alcohol while all the others are insoluble, but when a solution of the alkalies is dissolved in alcohol, a considerable part of the sodium meta silicate will be soluble. By precipitating the solution with barium chloride and adding alcohol and boiling for a few minutes and titrating while hot, the caustic soda is from 98 to 100% soluble while all the other alkalies are totally insoluble, thereby furnishing a method of determining sodium hydroxide when in solution with the three other alkalies. When a saturated solution of barium chloride is added to the alkali and the solution boiled for a few minutes, cooled and titrated, the sodium hydroxide was 100% soluble, sodium meta silicate was 93.5% soluble, the soda ash totally insoluble and the trisodium phosphate was only approximately 1.5% soluble. This titration will include, for all practical purposes, only the sodium hydroxide and sodium meta silicate. Hence by subtracting the sodium hydroxide portion from the portion representing the sodium hydroxide and sodium meta silicate, the silicate portion can be determined.

Trisodium phosphate and soda ash are the only alkalies which form a reversible reaction, (3) therefore by titrating the solution to the methyl orange end point and boiling the solution to break down the H_2CO_3 and expelling the CO_2, and titrating back to the phenolphthalein end point a differential reaction for phosphates is established. Approximately one third of trisodium phosphate is active from the phenolphthalein to the methyl orange end point. The solution is titrated back with standard alkali until the solution is alkaline to methyl orange, and the reading taken and the titra-

TABLE 1
Some properties of the alkalies

DISTINGUISHING PROPERTIES OF THE ALKALIES	ALKALIES			
	Per cent of total alkaline ingredients			
	NaOH	Na₂CO₃	Na₃PO₄	Na₂SiO₃
Active at phenolphthalein end point	100.00	50.00	42.12	93.50
Active from phenolphthalein to methyl orange end point		50.00	35.70	6.50
Inert portion of alkali			22.18	
Solubility in hot alcohol after precipitating with barium chloride. Phenolphthalein	98.00			
Solubility at phenolphthalein end point after ppt. with barium chloride and boiling	100.00		1.59	93.50
Solubility from phth. to methyl orange end pt. after ppt. with barium chloride and boiling		97.70	61.97	2.70
Reversible reaction after boiling to expel CO₂			99.75	

tion continued to the phenolphthalein end point. The portion from the methyl orange end point to the phenolphthalein end point represents one third of the trisodium phosphate. This completes the determination of three of the four constituents, and the fourth one, soda ash, may be determined by the difference between the total acid required to bring the solution to the methyl orange end point and the amount representing the total of the other three alkalies.

Table 2 gives the percentage composition of each of the alkalies for each of the steps in the analysis, and the total composition is given in table 3.

TABLE 2

Percentage of active ingredients in the alkalies as determined by each step in the proposed methods

	Na_2PO_4-$12H_2O$ TECH.	NaOH (95% NaOH + 5% Na_2CO_3) COMM.	Na_2CO_3-H_2O C. P.	Na_2SiO_3-$5H_2O$ COMM.
Active Na_2O (phenolphthalein end point)	11.22	77.58	25.79	28.40
Inactive Na_2O (methyl orange end point)	9.06	1.48	25.79	1.97
Total Na_2O	20.28	79.06	51.58	30.37
$BaCl_2$ + alcohol and boil		96.25		
$BaCl_2$ and boil	1.59	96.25		95.50
Back titration after boiling	99.75			
Phenolphthalein end point	135.40	98.00	101.50	95.50
Methyl orange end point	106.90	1.75	101.50	6.50
Total (phenolphthalein and methyl orange)	121.10	99.75	101.50	102.00

TABLE 3

Percentage composition of the alkalies

CONSTITUENTS	COMMERCIAL CAUSTIC SODA 95% NaOH 5% Na_2CO_3	C. P. SODA ASH Na_2CO_3-H_2O	COMMERCIAL SODIUM META SILICATE Na_2SiO_3-$5H_2O$	TECHNICAL TRISODIUM PHOSPHATE Na_3PO_4-$12H_2O$
NaOH	95.00			
Na_2CO_3	4.63	86.72		
Na_2CO_3-H_2O		101.50		
Na_3PO_4				43.05
Na_3PO_4-$12H_2O$				99.75
Na_2SiO_3			58.67	
Na_2SiO_3-$5H_2O$			102.00	
Moisture and inert material by difference	0.37	13.28	41.33	56.95

A washing powder was made up of equal parts by weight of each of the four alkalies and analyzed according to the proposed method, the results being shown in table 4. The analysis checked uniformly closely with the actual composition, the greatest variation being -2.47% for Na_2SiO_3-$5H_2O$.

TABLE 4

Analysis of a washing powder made up of equal parts by weight of caustic soda, soda ash, trisodium phosphate and, sodium meta silicate

CONSTITUENTS	ACTUAL COMPOSITION	ANALYSIS	ERROR
NaOH	23.75	23.75	
Na_2CO_3	22.93	22.51	− .42
Na_2CO_3-H_2O	26.25	26.35	+ .10
Na_3PO_4	10.76	11.28	+ .52
Na_3Po_4-$12H_2O$	25.00	26.13	+1.13
Na_2SiO_3	14.68	12.96	+1.72
Na_2SiO_3-$5H_2O$	25.00	22.53	−2.47
Total alkaline ingredients	72.12	70.50	−1.62
Active Na_2O	35.75	35.70	− .05
Inactive Na_2O	9.58	8.73	− .85
Total Na_2O	45.33	44.43	− .90
Moisture and inert material by difference	27.78	29.50	+1.72

A 4.0% solution of the washing powder was analyzed and the results given in table 5. The analysis was much closer to the actual composition in the washing solution than for the washing powder, the reason of course being due to the multiplication of the error in calculating the results for the washing powders.

As shown in table 5, the maximum error was −.10% calculated as Na_2SiO_3-$5H_2O$ and only − .07% calculated as Na_2SiO_3; therefore for a plant test as a check on the washing solutions, this method would give very satisfactory results, the error being so slight that it would be insignificant.

PROPOSED METHOD OF ANALYSIS

The following outline is the proposed method for analyzing a washing powder containing any or all of the four cleaning alkalies, caustic soda, soda ash, trisodium phosphate, and sodium meta silicate.

1. Weigh out ten grams of the washing powder and transfer to a 250 cc. volumetric flask and fill to the mark with distilled water.

2. Shake thoroughly until all the alkali is dissolved and the solution becomes homogeneous throughout.

3. Pipette 10 cc. of the solution into a 200 cc. pyrex Erlenmeyer flask, and titrate to the phenolphthalein end point with N/4 sulfuric acid. Record the cc. of acid required as (1). Now add methyl orange indicator and titrate to the end point. Record this titration as (2). Heat the solution gently over a hot plate or on an asbestos buffer over a Bunsen burner, bringing to a gentle boil, and boiling slowly for 15 minutes. Cool to room temperature and titrate back to the alkaline side of the methyl orange end point with N/4 NaOH. Record this titration as (3). Continue the titration to the very faintest pink phenolphthalein end point. Record this titration as (4).

Analysis of a 4.0% solution of a washing powder made up of equal parts by weight of caustic soda, soda ash, trisodium phosphate and sodium meta silicate

CONSTITUENTS	ACTUAL COMPOSITION	ANALYSIS	ERROR
Na_2CO_3 .. .	0.92	0.90	− .02
NaOH .	0.95	0.95	
$Na_2CO_3 \cdot H_2O$	1.05	1.05	
Na_3PO_4	0.43	0.45	+ .02
$Na_3PO_4 \cdot 12H_2O$	1.00	1.05	+ .05
Na_2SiO_3	0.59	0.52	− .07
$Na_2SiO_3 \cdot 5H_2O$	1.00	0.90	− .10
Total alkaline ingredients	2.89	2.82	− .07
Active Na_2O	1.43	1.43	
Inactive Na_2O	0.38	0.35	− .03
Total Na_2O	1.81	1.78	− .03

4. Pipette another 10 cc. sample into a 200 cc. pyrex Erlenmeyer flask. Add 10 cc. of a saturated solution of barium chloride and boil vigorously for five minutes. Cool to room temperature and titrate to the phenolphthalein end point with N/4 sulfuric acid. Record this titration as (5).

5. Pipette another 10 cc. sample into a 200 cc. pyrex Erlenmeyer flask. Add about one gram of pure barium chloride crystals and shake vigorously. Allow to stand for 10–15 minutes and add 50 cc. of 95% neutral ethyl alcohol (neutral denatured alcohol will suffice). Heat very slowly on a hot plate or on an asbestos buffer over a bunsen burner to boiling, being very careful not to ignite the fumes from the alcohol. Shake vigorously throughout the heating process to prevent bumping. Boil gently for ten minutes, and titrate while hot to the phenolphthalein end point with N/4 sulfuric acid. Record this titration as (6).

Consider (1) + (2) as A. Twice (3) + (4) as B, and (5) as C.

Calculation results:

$$(1) \times 1.94 = \% \text{ active } Na_2O \text{ in the sample.}$$
$$(2) \times 1.94 = \% \text{ reserve } Na_2O \text{ in the sample.}$$
$$(A) \times 1.94 = \% \text{ total } Na_2O \text{ in the sample.}$$
$$(4) \times 23.75 = \% \ Na_3PO_4 - 12 \ H_2O \text{ in the sample.}$$
$$(4) \times 10.25 = \% \ Na_3PO_4 \text{ (anhydrous) in the sample.}$$
$$(6) \times 2.5 = \% \ NaOH \text{ in the sample.}$$
$$(5 - 6) \times 6.63 = \% \ Na_2SiO_3 - 5 \ H_2O \text{ in the sample.}$$
$$(5 - 6) \times 3.81 = \% \ Na_2SiO_3 \text{ (anhydrous) in the sample.}$$
$$A - (B + C) \times 3.31 = \% \ Na_2CO_3 \text{ in the sample.}$$
$$A - (B + C) \times 3.88 = \% \ Na_2CO_3 - H_2O \text{ in the sample.}$$

To analyze a sample of washing solution, cool to room temperature and pipette 9.6 cc. (10 grams) of the well mixed solution for a sample instead

of using 10 cc. as in analyzing a washing powder. Follow the same procedure used for washing powder but begin with step 3.

Calculation of results:

(1) $\times .0775 = \%$ active Na_2O in the solution.
(2) $\times .0775 = \%$ reserve Na_2O in the solution.
(A) $\times .0775 = \%$ total Na_2O in the solution.
(4) $\times\ \ .95 = \%$ $Na_3PO_4 - 12 H_2O$ in the solution.
(4) $\times\ \ .41 = \%$ Na_3PO_4 (anhydrous) in the solution.
(6) $\times\ \ .10 = \%$ $NaOH$ in the solution.
$(5-6) \times .153 = \%$ Na_2SiO_3 (anhydrous) in the solution.
$(5-6) \times .265 = \%$ $Na_2SiO_3 - 5 H_2O$ in the solution.
$A - (B+C) \times .133 = \%$ Na_2CO_3 in the solution.
$A - (B+C) \times .155 = \%$ $Na_2CO_3 - H_2O$ in the solution.

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note that in the case of *S. cremoris*, more substrains were obtained which were (maltose +, sucrose −) than were obtained of those which resembled the parent culture (maltose −, sucrose −). The next experiment throws additional light on this phenomenon.

Substrains, from the original culture of *S. cremoris*, which were (maltose −, sucrose −), (maltose +, sucrose −) and (maltose +, sucrose +) were plated and about 100 colonies isolated from each. Unfortunately, we had not retained a substrain which was (maltose −, sucrose +) from our earlier experiments, and this type was not represented in these tests. The results of this experiment are given in Table 2.

TABLE 2

Fermentative variation among strains isolated from different substrain types from the original culture of Streptococcus cremoris

SUBSTRAIN	PER CENT MALTOSE − SUCROSE −	PER CENT MALTOSE + SUCROSE −	PER CENT MALTOSE − SUCROSE +	PER CENT MALTOSE + SUCROSE +
Maltose −, Sucrose −	14	86	0	0
Maltose +, Sucrose −	5	95	0	0
Maltose +, Sucrose +	27	*73	0	*0

* Many of these cultures showed a very slight acidity in sucrose broth, indicating a feeble fermentation.

These data again show the strong tendency among the offspring of the parent culture to ferment maltose; and in addition the tendency to lose the power of fermenting sucrose, among the descendants of substrains which had that power.

The stock culture of *S. cremoris* used in these experiments, which was maintained in milk culture, was tested after the completion of the work and was still (maltose −, sucrose −). On this same point, in connection with our work on the colon bacteria (1), it was said: "It would seem probable that individual cell variants commonly occur in stock cultures just as they do when isolated in agar. It is an exceedingly nice question, which we shall not now attempt to answer, why these variants do not ordinarily make their presence evident in mass cultures. It is believed, however, that the data herein reported throw light on those relatively rare but authentic instances in which stock cultures have changed in their fermentative capacities."

DISCUSSION

This work confirms that of Sherman and Wing with colon bacilli, and presents some problems of interest and importance to students of the lactic acid streptococci. From the standpoint of classification, serious questions are raised concerning the value of the fermentation tests in the identification of the species, or varieties, which are contained in the general group.

The *S. lactis* group, using the term in a broad sense, is known to contain organisms which ferment, and others which do not ferment, arabinose, xylose, maltose, sucrose, mannitol and salicin. Orla-Jensen and Hansen (2) have reported a type which ferments raffinose, and Yawger and Sherman (3) have recently found a few strains which do not ferment lactose. Hence, there are eight test substances on which fermentative variability is known to occur within the group. Stark and Sherman (4) have shown that with arabinose, xylose, sucrose, and mannitol, all of the theoretically possible 16 combinations, with four variable characters, are to be found among the cultures of *S. lactis* described in the literature—rather strong evidence that these variations are random ones and not of taxonomic significance. If the number were increased to include the eight test substances known to give variable results, the possible number of combinations becomes 256. Were species to be recognized on such a basis, the mere selection of appropriate names for the new "species," shortly coming to light, would tax the ingenuity of a scholar of the classics.

This is not meant to imply that *S. cremoris* is not a species distinct from *S. lactis;* only that it is doubtful if a differentiation can be founded on the fermentation tests. As a matter of fact, we are inclined strongly to the belief that *S. cremoris* is a distinct species, and work now in progress in this laboratory leads us to hope that it will be possible, for the first time, to define this organism clearly.

SUMMARY

From a pure culture of *Streptococcus cremoris* which fermented neither maltose nor sucrose (maltose –, sucrose –), 458 substrains were isolated by the poured agar plate method. Of these, 217 were (maltose –, sucrose –). 229 were (maltose +, sucrose –), 11 were (maltose –, sucrose +), and one was (maltose +, sucrose +). A culture of *S. lactis* (maltose +, sucrose –) was more stable, yielding 756 substrains which were (maltose +, sucrose –), and one which was (maltose +, sucrose +).

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THE DETECTION AND SIGNIFICANCE OF ESCHERICHIA–AEROBACTER IN MILK[1,2]

III. CORRELATION OF TOTAL BACTERIAL COUNT AND PRESENCE OF THE COLI–AEROGENES GROUP

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INTRODUCTION

The coli-aerogenes group has long been used as an indicator of the sanitary quality of water. Studies of the prevalence of this group in milk and milk products have not been sufficiently extensive to permit definite conclusions. Many investigators believe that the total bacterial count is insufficient to show completely the sanitary quality of the milk and particularly of pasteurized milk, careless handling or insufficient heating may result in significant contamination and yet the total count may not be markedly increased. In such cases, the examination for members of the coli-aerogenes group may be of importance. However, it must be remembered that Beavens (1), and Minkin and Burgwald (2) showed that strains resistant to pasteurization may occur in milk. Stark and Patterson (3) tested 505 cultures from water, milk and feces and found all to be destroyed by 145° F. for 30 minutes.

Since recent reports have not cited much of the outstanding work on the significance of the colon group in milk, a portion of the literature on this subject will be briefly reviewed. Work, prior to 1925, on the isolation and significance of the colon bacilli in milk was done by Ayres, Cook and Clemmer (4); Hunter (5); and Finkelstein (6). The first mentioned investigators concluded that the colon group could be used to a limited extent in determining the efficiency of the cooling of the milk. Hunter observed a close correlation between total count and the number of colon organisms. Finkelstein found that the coli-aerogenes count would be under 100 per cc. in carefully handled raw milk. In pasteurized milk, he found that they were reduced to an average of 42 per cc. and in some cases none were found. However, the methods of isolating colon bacilli have been changed and the care used in the production of milk has increased. Later, Swenarton (7), using gentian violet lactose peptone bile medium, found that a high count of *B. coli* correlated with plants showing improper heating or cooling of milk.

Kline (8) found that there was little correlation between colon and total count in low count milk, and that in high count milk the correlation was insignificant.   The same general consideration held true in pasteurized milk but in certified milk there was a definitely lower percentage of samples with a count of under 10,000 per cc. showing colon.   Malcolm (9) found a definite correlation between the average bacterial count and the coli-form-positive samples.   Munchberg (10) observed a close relationship between the coli titre and bacterial or chemical tests for contamination.

Sherman and Wing (11) concluded that the colon test is of no special value as an index to the sanitary condition of the usual grade of raw milk, but in milk of under 10,000 total count, the colon test may act as a supplementary index of quality.   In such milk these organisms should number less than 100 per cc.   In certified milk they believed the recommendation of the American Association of Medical Milk Commission of less than 10 colon organisms per cc. to be satisfactory.

Barkworth (12), in a statistical examination of the interrelationship of the plate count, coliform content, and keeping quality, found that the variabilities were too great to permit forecasting one term from the other, but that an increase of coliform organisms reduced the keeping quality of the milk to the same extent as a seven-fold increase in plate count.   Moldavan (13) stated that "it is generally agreed that in most cases, positive results from samples of pasteurized milk are due to non-fecal organisms, the presence of which indicates faulty sterilization and improper pasteurization rather than fecal contamination."

McCrady and Langevin (14) found the coli-aerogenes organisms were practically absent from one cc. quantities at the pasteurizing vat but that contamination often occurred in the cooling or bottling process, although it appeared that properly pasteurized milk should not contain these organisms in one cc. portions in more than 10 to 20 per cent of tests.

Slack and Maddeford (16), in examining 25 samples of raw milk sold to pasteurizing plants, found 4 per cent to contain no colon organisms in 10 cc. of milk, 12 per cent to be positive only in 10 cc., 12 per cent positive in 1 cc., 20 per cent positive in 0.1 cc., and 52 per cent positive in amounts less than 0.1 cc.   In 100 samples of bottled raw milk they found no colon organisms in 30 per cent of the 10 cc. samples.

Moore and Fuller (17), in comparing the total and the colon count of milk found that the majority of farms producing milk free of colon organisms likewise had lower counts than the farms from whose milk colon organisms were isolated, yet there was no direct relationship between the score placed on the farm and the presence of colon organisms in the milk or between the score and average bacterial count.   Davis (18) concludes that the *B. coli* test is of no value as an indicator of gross contamination, but does serve to indicate faulty production and unsterilized utensils.   He found that no growth of these organisms occurred in milk held below 10° C.

Chilson, Yale and Eglinton (19) observed that the test for the colon group "should supplement and not supplant the standard plate count," in detecting contamination of pasteurized milk, since "there were instances in which one or the other of the methods indicated recontamination when the other did not."

<div align="center">EXPERIMENTAL</div>

Three hundred thirty-one samples of raw milk were examined for total bacterial count using Standard Methods of Milk Analysis procedures (1934), the coli-aerogenes being isolated on five liquid and nine solid media in groups of two liquid and two solid media with 50 samples in each group, as reported in a previous paper. In addition 50 samples were plated in neutral red bile agar in 1 cc. amounts and in dehydrated tryptone glucose milk medium of Bower and Hucker (20), duplicate platings being made in each case. The latter medium was incubated for 48 hours at 32° C. It has been shown that higher counts may be obtained on a modified medium at lower temperatures, than can be obtained on standard agar at 37° C. These results have been confirmed in this laboratory.

<div align="center">TABLE 1</div>

Prevalence of coli-acrogenes in 331 samples of raw milk grouped on basis of total count on standard agar

TOTAL COUNT	NUMBER OF COLI-AEROGENES PER CC.			
	0	1–9	10–99	100
	per cent	per cent	per cent	per cent
Under 10,000	36.4	32.8	23.8	7.0
Over 10,000	21.1	8.0	28.6	42.3
Under 50,000	31.8	22.6	27.9	17.7
Over 50,000	16.2	8.1	20.3	55.4
Number of Escherichia per cc.				
Under 10,000	53	25	18	4
Over 10,000	47	10	17	26
Under 50,000	53	18	19	10
Over 50,000	37	10	16	37
Number of Aerobacter per cc.				
Under 10,000	80	12	5	3
Over 10,000	70	4	11	15
Under 50,000	74	10	10	6
Over 50,000	75	3	4	18
Number of Intermediates per cc.				
Under 10,000	82	12	4	2
Over 10,000	71	3	11	15
Under 50,000	77	10	9	4
Over 50,000	70	2	6	22

Thirty-one samples of pasteurized milk and 25 samples of milk meeting the requirements of certified milk were examined, the coli-aerogenes group being determined on two liquid and three solid media. The generic separation was made in accordance with the methods suggested in the 7th edition of Standard Methods of Water Analysis.

<div align="center">RESULTS</div>

Table 1 shows the results obtained with 331 samples of raw milk, which were separated into different grades based on total count and the number of all colon organisms and of the different members of this group. The percentage of samples negative for colon organisms does not vary significantly in samples under or above 10,000 total count; however, 69.2 per cent of the samples with counts under 10,000 showed less than 10 colon organisms per cc., while 29.1 per cent of the samples having a total above 10,000 contained this number of colon organisms. It must be remembered that 9.4 to 22 cc. of milk were used for inoculation, so that the actual number of coli-aerogenes per cc. might be lower than is indicated.

On comparing the various members of the coli-aerogenes group with the total counts, it appears that the group as a whole gives a better correlation with total count than any of the individual members.

Of these samples 27.9 per cent were negative for colon in 0.01 cc., 19.1 per cent were positive in 1 cc., 26 per cent were positive in 0.1 cc. and 27 per cent were positive in 0.01 cc. If the 1 cc. positives are eliminated, 47.0 per cent of the samples would be negative in all amounts, thus corresponding closely with the results of Malcolm and of Klimmer, Haupt and Borches, as shown in Table 2.

<div align="center">TABLE 2</div>
<div align="center">Percentage of coli-aerogenes found in various amounts of raw milk by different investigators</div>

	MALCOLM (9)	KLIMMER, HAUPT & BORCHES (15)	PRESENT DATA
Negative in 0.1 cc.	48.3	57.0	47.0
Positive in 0.1 cc.	21.4	23.5	26.0
Positive in 0.01 cc.	14.0	10.0	27.0
Positive in 0.001 cc.	16.3	23.5	

The average total count of the colon-positive samples was 140,500 per cc. or 2.9 times that of the colon-negative samples, which was 48,270. Malcolm, in the investigation cited, found an average count of 160,577 in coliform-positive and 25,295 per cc. in the coliform-negative samples, the positive samples having 6.3 times as many bacteria per cc. as the negative

The 50 samples of raw milk, plated on neutral red bile and tryptone glucose milk medium, showed a pronounced relationship between colon titre

and total count, however, the number of samples is not sufficient for the drawing of definite conclusions.   The results given in Table 3 show 93.5 per

TABLE 3

Prevalence of coli-aerogenes in fifty samples of raw milk of different total counts on glucose tryptone agar at 32 C.

TOTAL COUNT	NUMBER OF COLI-AEROGENES PER CC.			
	0	1-9	10-99	100
	per cent	per cent	per cent	per cent
Under 10,000	93.5	6.5	0	0
Over 10,000	22.2	77.8	0	0
Under 50,000	85	15		
Over 50,000	0	100		

cent of the samples, with a total count of under 10,000, to be negative in all amounts while 6.5 per cent were positive in 1 cc. amounts.   The samples with a total count of over 10,000 showed 22.2 per cent to be negative in all amounts and 77.8 per cent positive in 1 cc. amounts.   The average count of the colon-negative samples was 6,650; that of the colon-positive 80,000 or 12 times as many.   The logarithmic average of the colon-negative samples, computed by the method of the U. S. Public Health Service Milk Ordinance and Code (21), was 5,000; of the positive 45,000 or 9 times as many.

Thirty-eight per cent of the 31 samples of pasteurized milk contained colon organisms with an average total count of 17,900 while 62 per cent were negative and had an average count of 4,171, the positive samples having 4.3 times as many bacteria per cc.   All of the positive samples were obtained from one plant where coli-aerogenes organisms were found from the cooler, bottler, and from the bottled milk, this plant had an exceptionally high bacterial count even in the pasteurizing vat.   The two other plants studied showed no colon organisms in the bottled milk and the count never exceeded 700 per cc.   The frequency of the colon organism in relation to total count is shown in Table 4.

TABLE 4

Prevalence of coli-aerogenes in 31 samples of pasteurized milk of different total counts on standard agar

TOTAL COUNT	NUMBER OF COLI-AEROGENES PER CC.			
	0	1-9	10-99	100
	per cent	per cent	per cent	per cent
Under 1,000	100			
1-10,000 ..	40	40	10	10
Over 10,000	30	40	30	

The 25 samples of "certified" milk gave an average total count of 1,686 for the colon-positive samples which was 1.6 times as great as 1,017, the

average count of the colon-negative samples. No colon organisms were found in 0.1 cc. of these samples. Since no samples were examined in which the total count exceeded 10,000, comparison of Kline's (8) results could not be made.

<center>DISCUSSION</center>

It is felt from the results obtained with pasteurized milk that the standard proposed by Swenarton, "that not more than 20 per cent of 0.1 cc. portion shall show *E. coli*" or that "positive results shall not occur in more than 10 per cent of 0.1 cc. portions when 10 or more samples are examined," is not unduly stringent. It would seem entirely possible for this standard to be met if based on the results of 1 cc. portions, which is the suggestion of McCrady and Langevin (14), who concluded that "properly pasteurized milk should not contain coli-aerogenes bacteria in 1 cc. portions, in more than 10 to 20 per cent of tests." Slack and Maddeford (16) found that colon bacilli in 0.1 cc. indicates recontamination and that absence in 50 cc. may "reasonably be expected." A correlation of 38 per cent between low count and absence of colon bacilli was found by these investigators. It is believed that from these results and from those of other investigators, an accurate test for coli-aerogenes organisms in pasteurized and in certified milk would be a valuable aid in determining the sanitary quality of the milk.

This is well emphasized in the present investigation of the one pasteurizing plant from which samples positive for colon were obtained. As indicated, they were found present in samples taken from the milk at every point after it had passed over the cooler, at the same time no increase in total bacterial count was observed. Thus the colon examination indicated faulty methods or equipment while the total count failed to show any contamination occurring.

From the work with raw milk it is believed that no standard for this grade can at the present time be set, however, it would seem possible that reasonably careful production should yield a product having fewer than 10 colon organisms per cc. in 70 to 80 per cent of examined samples and that in no instance should 100 per cc. be exceeded. Additional work using tryptone glucose agar or other modified agar at 32° C. for the comparison of total count and presence of the coli-aerogenes group is desirable.

<center>SUMMARY</center>

A comparison of the total count on standard agar and presence of colon organisms showed the colon-positive samples of raw milk to have a total count of 2.9 times that of the colon-negative. Less than 10 colon organisms per cc. were found in 69.2 per cent of samples with a total count of less than 10,000 bacteria per cc. No pasteurized samples with counts under 1,000 contained colon organisms, the count of colon-positive samples being 4.3

times higher than colon-negative samples. No colon organisms were found in 0.1 cc. of "certified" milk.

Total bacterial counts made on tryptone glucose milk medium at 32° C. gave excellent correlation with colon titre, since 93.5 per cent of samples with a total count under 10,000 were negative for colon organisms. The average count of colon-positive samples was 12 times higher than that of colon-negative samples, being 6,650 and 80,000 per cc. respectively.

The presence of the coli-aerogenes group in raw milk of high bacterial count, would seem to be of little significance, in milk of low count the number of colon bacteria might be limited to the presence in 1 cc. amounts in 70–80 per cent of samples examined. In order to determine the sanitary condition under which milk is produced, further work to determine a standard for these organisms is desirable.

The presence of coli-aerogenes organisms in 1 cc. of pasteurized milk in 10 to 20 per cent of samples would seem sufficient to indicate contamination, which, as is shown in this investigation, might not be indicated by total bacterial counts. This test in pasteurized milk is particularly desirable.

The present standards for certified milk in respect to colon content are quite lenient.

Lactose taurocholate agar was found unsatisfactory in previous experiments in this series so that the adoption of a more satisfactory method for the detection of these organisms would be desirable and if this is realized a more stringent standard would seem possible. The value of a test to indicate contamination in a milk to be consumed raw can not be too highly stressed.

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CHANGES IN WEIGHT OF NEW BORN DAIRY CALVES AS RELATED TO THE METHOD OF FEEDING*

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INTRODUCTION

The fact that new born human babies lose part of their birth weight the first few days following birth has been established for some time. Members of the medical profession have expressed an interest in the behavior of dairy calves for the corresponding period of time. The question as to whether or not calves lose weight and whether or not the dairyman does anything about it has been asked. With this question before us a large number of calves have been weighed in an effort to furnish a satisfactory answer and to make recommendations as to the best method of starting new born dairy calves.

EXPERIMENTAL PROCEDURE

The calves used in this experiment were both purebred Guernseys and grades with at least seven crosses of purebred Guernseys. Both males and females were used.

Each calf was weighed immediately following birth and at eight o'clock each morning thereafter until the age of fourteen days. The calves were divided into three separate groups. The thirteen calves of the first group were taken from their dams immediately after birth without nursing. A small amount of colostrum milk was given at once and thereafter they were fed each morning and evening from their dam's milk. The amount fed each calf ranged from three to six pounds per day depending on the weight of the calf. The amount of milk fed per day was increased as rapidly as the calf would take it until the amount was equal to ten per cent of the body weight.

The twenty-six calves in the second group were left with their dams for a period of forty-eight hours. They were then separated from their dams and food was withheld for a period of twenty-four hours at the end of which time they were started on hand feeding of whole milk at the same rate as group one. The third group contained fourteen calves which were left with their dams for a period of ninety-six hours and then cared for in exactly the same manner as group two.

A summary of the results obtained from the three groups is given in Table 1. The data for the human babies was obtained through the courtesy

TABLE 1
Changes in weight

TIME AFTER BIRTH-DAYS	BIRTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Weight Pounds	Group I Calves Removed from Dams at Birth (Average for 13 calves).														
Weight Pounds	65.653	64.73	64.692	65.73	66.846	68.23	69.538	70.73	71.807	73.23	74.50	75.884	77.384	78.961	80.384
Weight Pounds	Group II Calves Left with Dams 48 hours (Average for 26 calves).														
Weight Pounds	64.98	67.269	67.634	65.153	65.173	65.615	66.326	67.538	68.557	69.307	69.557	70.346	70.73	71.307	71.807
Weight Pounds	Group III Calves Left with Dams 96 hours (Average for 14 calves).														
Weight Pounds	65.607	67.50	67.785	68.107	69.178	68.25	66.535	66.428	66.785	67.071	67.50	67.928	68.678	69.214	69.821
Weight Pounds	Human Babies (Average for 21 Babies).														
Weight Pounds	7.813	7.711	7.401	7.22	7.15	7.178	7.231	7.291	7.533						

of the management of the Itasca County Hospital, Grand Rapids, Minnesota, from the records of twenty-one babies born at the hospital. They are shown for only eight days because nearly all the babies were removed from the hospital at the end of that period. The figures are given for the sole purpose of comparison as they probably represent fairly well the typical changes of weight in the human species following birth.

DISCUSSION OF RESULTS

A study of Table 1 shows that the calves of Group I suffered a daily loss for the first two days, probably due to the small amount of milk they would take. There was a continuous daily gain for the remaining fourteen days. The loss was so slight for the first two days that one day of gain compensated for the entire loss and could probably be accounted for largely by the difference in fill.

The table for Group II shows that the calves gained daily for the first two days and then lost on the third day which represents the time food was withheld after the calves were separated from their dams. On the fourth day, after they had received milk by hand feeding the preceding twenty-four hours, the calves started to gain weight and there was a steady daily gain for the balance of the fourteen day period. In order to check this loss on the third day and make certain that it was induced by the period of fasting preceding hand feeding, the calves of Group III were left with their dams for the ninety-six hour period.

The table for Group III shows about the same average gain during the first two days as for Group II and a continued gain for the next two days, while the calves were nursing their dams. On the fifth day, which was immediately after the twenty-four hour period of fasting, a decline occurred. The calves also lost weight on the sixth and seventh day and then made a steady gain each day during the balance of the experiment.

In both Groups II and III there was a steady gain immediately following birth until the calves were removed from their dams and subjected to a twenty-four hour fasting period.

The fact that the calves failed to take enough milk during the period of learning to drink probably accounts for the loss of weight in Group I during the first days. That the calves in Group III continued to lose weight for a period of three days after taking them from their dams can only be accounted for by the fact that they would not drink as much milk at the start as the calves in Group II. Their average loss exceeded Group II by only .269 lbs. even though it occurred over a longer period.

The important fact brought out in this study is the decided advantage in gain shown at the end of the fourteen day period by the calves not allowed to nurse, over those that nursed, also the advantage of those left with their dams forty-eight hours over those left with their dams ninety-six

hours.   At birth Group I averaged .673 lbs. more than Group II and .046 lbs. more than Group III but at the end of the fourteen day period they averaged 8.577 pounds more than Group II and 10.563 pounds more than Group III giving them an advantage in gain of 7.904 pounds and 10.517 pounds over Groups II and III respectively.

CONCLUSIONS

1. Dairy calves do not suffer a natural loss in weight immediately following birth as indicated by the immediate gain made by all calves when allowed to nurse their dams.

2. Dairy calves seem to get a better start during the first fourteen days when removed from their dams immediately after birth and started on hand feeding.

3. The calves in this experiment that were not allowed to nurse were much easier to teach to drink than those that nursed their dams.   The rapidity and ease with which the calves in this experiment learned to drink was in direct proportion to the length of time they were allowed to nurse.

4. The average birth weight of the fifty-three Guernsey calves used in this experiment was 65.3 pounds.

American Dairy Science Association Announcements

ANNUAL MEETING

1 P. M.–9 P. M.—Registration, Dairy Industry Building, Agricultural College Campus.

TUESDAY, JUNE 22, 1937

8 A. M.–9 P. M.—Registration, Dairy Industry Building, Agricultural College Campus.
9–10:30 A. M.—Extension Section, Room 303, Dairy Industry Building.
10:30–10:40—Rest period.
10:40–12:00—Extension Section, Room 204, Dairy Industry Building.
12:00– 1:00—Lunch, Agricultural College Cafeteria.
1:00– 4:00—Demonstration—Reproduction, Dairy Barn.
1:00– 4:00—Ice Cream Scoring, Dairy Industry Building.

7:00– 8:00—General Meeting, Temple Theater.
8:15—General Get-together, Lawn, Carrie Belle Raymond Hall.

WEDNESDAY, JUNE 23, 1937

8:00–12:00—Registration, Dairy Industry Building, Agricultural College Campus.
8:00– 9:00—Sectional Committee Meetings:
    Production, Room 206, Dairy Industry Building.
    Manufacturing, Animal Husbandry Hall.
    Chemical Methods of Analysis, Animal Husbandry Hall.
    Extension, Animal Husbandry Hall.
9:00–12:00—General Session, College Activities Building, Agricultural College Campus.
12:00– 1:00—Lunch, Agricultural College Cafeteria.
1:00– 2:10—Sectional Meetings:
    Production, Room 301, Dairy Industry Building.
    Manufacturing, Room 303, Dairy Industry Building.
2:10– 2:20—Rest period.
2:30– 4:00—Sectional Meetings:
    Production, Room 301, Dairy Industry Building.
    Manufacturing, Room 303, Dairy Industry Building.
4:00– 5:00—Section Committee Meetings:
    Production, Room 206, Dairy Industry Building.

Manufacturing, Animal Husbandry Hall.
Extension, Animal Husbandry Hall.
Visit Morrill Hall and Capitol.

8 : 00—Get-together, social time, Carrie Belle Raymond Hall, or Shrine Country Club.
Entertainment features.

THURSDAY, JUNE 24, 1937

8 : 00—Extension Exhibits open.
8 : 00– 9 : 50—Sectional Meetings:
Production, Room 301, Dairy Industry Building.
Manufacturing Section, Room 303, Dairy Industry Building.

9 : 50–10 : 00—Rest period.
10 : 00–12 : 00—Sectional Meetings:
Production, Room 301, Dairy Industry Building.
Manufacturing Section, Room 303, Dairy Industry Building.
12 : 00– 1 : 00—Complimentary Lunch, Dairy Husbandry Department.
1 : 00– 2 : 00—Sectional Business Meetings:
Production, Room 301, Dairy Industry Building.
Manufacturing, Room 303, Dairy Industry Building.
Extension, Room 204, Dairy Industry Building.
2 : 00– 3 : 00—Sectional Meetings:
Production, Room 301, Dairy Industry Building.
Manufacturing, Room 303, Dairy Industry Building.
Extension, Room 204, Dairy Industry Building.
3 : 00– 4 : 00—Dairy Education and Teaching Problems, Room 301, Dairy Industry Buildings.

6 : 30—Subscription Banquet, Shrine Country Club.
Followed by entertainment.

FRIDAY, JUNE 25, 1937

8 : 00– 9 : 00—General Business Session, Room 301, Dairy Industry Building.
9 : 00–12 : 00—Sectional Meetings:
Production, Room 301, Dairy Industry Building.
Manufacturing Section, Room 303, Dairy Industry Building.

NOMINATIONS FOR THE BORDEN AWARDS FOR WORK IN THE PRODUCTION AND PROCESSING FIELDS FOR 1937

The recipients of the two annual Borden awards, each consisting of $1000 and a gold medal, for the most meritorious research in the field of dairy cattle production and in the processing field, will be selected by the awards committee of the American Dairy Science Association.   Send your nomination for these honors to the Secretary of the American Dairy Science Association, Department of Dairy Technology, University of Ohio, Columbus, Ohio, so that it will reach him not later than March 1, 1937.   The awards will be made for (1) the most outstanding research work in the production field, breeding, feeding, farm sanitation or quality production, and other phases of production work, and (2) for outstanding research in the processing field such as improvement in equipment or methods in the handling of milk or cream and the production of milk products.   Nominations should be made for those whose work has been completed and published during the five-year period ending December 31, 1936.

Those who are eligible for consideration for the awards: Any living citizen of the United States or Canada   There are no limitations as to age or sex.

Since Borden awards are also being made for meritorious work in basic science as related to, or as it affects the Dairy Industry; for work in basic research on vitamins or other nutritional aspects of milk products; for work in the practical application of the findings in nutritional research; and for work in public health as related to the Milk Industry, these awards to be administered by other scientific societies, these phases of research work as applied to the dairy industry should not be considered in making your nominations for research in the production and the processing fields.

Each member of the American Dairy Science Association is entitled to make nominations for these awards.   The form for making nominations is as follows:

TO THE SECRETARY, AMERICAN DAIRY SCIENCE ASSOCIATION

I, the undersigned member of the American Dairy Science Association nominate
for the Borden award for 1937 in the field of production or processing for his contribution entitled

and delivered before
or published in
(Give details of publication references and if possible enclose copies.)
Signed:

THE 1936 COLLEGIATE STUDENTS' NATIONAL
DAIRY CATTLE JUDGING CONTEST

The 1936 students' national contest in judging dairy cattle was held at the National Dairy Show, Dallas, Texas, October 12, 1936. The cattle in each ring were placed by a special committee consisting of coaches with teams in the contest. The placing of the different animals depended upon the average placing of each animal by all of the coaches who served as judges.

Twenty teams competed in the contest, judging rings of the five dairy breeds.

Five high individuals on each breed

Place	Contestant's Name	College Represented
	Ayrshire	
1	H. R. Hofstrand	Iowa
2	Martin Baugher	Missouri
3	David Carder	Nebraska
4	Chas. Beer	Kansas
5	H. N. Haferbecker	Wisconsin
	Brown Swiss	
1	E. J. Preslik	Wisconsin
2	Lawrence Johnson	Michigan
3	H. N. Haferbecker	Wisconsin
4	Elmer Dawdy	Kansas
5	David Carder	Nebraska
	Guernsey	
1	R. O. Bergstrom	Wisconsin
2	H. N. Haferbecker	Wisconsin
3	E. J. Preslik	Wisconsin
4	Ivan Bowman	Nebraska
5	S. J. Taylor	Texas A. & M.
	Holstein	
1	Brooks Naylor	Minnesota
2	E. J. Preslik	Wisconsin
3	Charles Beer	Kansas
4	J. L. Leslie	Ontario
5	J. S. Taylor	Texas A. & M.
	Jersey	
1	Lawrence Johnson	Michigan
2	Clayton Chappell	Tennessee
3	Goodwin Soustegaard	Minnesota
4	Charles Beer	Kansas
5	Noel Ralston	Missouri

Five high individuals—all breeds

Place		Contestant's Name	College Represented
1	. . . .	Preslik, E. J.	Wisconsin
2	....	Soustegaard, Goodwin	Minnesota
3	. .	Naylor, Brooks	Minnesota
4	.. . .	Haferbecker, H. N.	Wisconsin
5	. ...	Teague, F. M.	Iowa

Five high teams—by breeds

Place	Team	Place	Team
	Ayrshire		*Brown Swiss*
1	Iowa	1	Wisconsin
2	Kansas	2	Nebraska
3	Nebraska	3	Kansas
4	South Dakota	4	Cornell
5	Minnesota	5	Texas Tech.

Place	Team	Place	Team
	Guernsey		*Holstein*
1	Wisconsin	1	Minnesota
2	Minnesota	2	Ontario
3	Michigan	3	Nebraska
4	Nebraska	4	Texas A. & M.
5	Kansas	5	Wisconsin

Place	Team
	Jerseys
1	Texas A. & M.
2 .	Kansas
3 . .	Minnesota
4	Missouri
5	Michigan

Team standing—all breeds

Place	Team	Points Scored	Place	Team	Scored Points
1	Minnesota	4347.3	11	Tennessee	4119.3
2	Kansas	4313.9	12	Ontario	4047.0
3	Wisconsin	4312.6	13 .	Oregon	3962.3
4	Nebraska	4311.9	14 .	Ohio	3937.9
5	Texas A. & M.	4235.2	15 . ..	South Dakota	3902.0
6	Texas Tech.	4181.3	16 .	New Mexico	3840.9
7	Iowa	4181.1	17 .	Purdue	3719.9
8	Cornell	4159.1	18 .. .	Virginia	3689.7
9	Michigan	4156.4	19	Arkansas	3667.2
10	Missouri	4129.8	20	Mississippi	3419.1

JOURNAL OF DAIRY SCIENCE

GASTRIC DIGESTION OF SOYBEAN FLOUR*

LaVAN SHOPTAW, D. L. ESPE AND C. Y. CANNON
Dairy Husbandry Subsection, Iowa Agricultural Experiment Station

Most work with milk substitutes for calves has taken the form of feeding trials. Though soybeans have a high nutritive value they have not proved entirely satisfactory for calf feeding when used as a gruel to replace milk (6). In order to better understand the physiological basis of digestion, calves were prepared with gastric fistulas and Pavlov pouches. The method of studying digestion by means of gastric fistulas has already been described (3). Pavlov pouches have not been generally used with ruminants although Belgowski (1) in 1912 reported the successful use of the technique with calves while seven years earlier, Grosser (4) reported its use in goats.

Any milk substitute to be successful in rearing calves must have certain physical as well as chemical properties in common with milk. Soybean flour as placed on the market for infant feeding is more like milk solids than the product used in this experiment in that much of the fiber has been removed while considerable of the fat has been retained. The analyses of soybean flour prepared for livestock purposes, and dry skim milk, are given below (table 1).

TABLE I
Percentage composition of soybean flour and dried skim milk

| | WATER | ASH | PROTEIN | CARBOHYDRATES | | FAT |
				Fiber	N.F.E.	
Soybean flour ..	7.0	3.0	45.0	7.0	32.0	6.0
Dried skim milk	6.2	8.0	34.8		50.0	0.9

When soybean flour is added to water, the mixture must be constantly agitated in order to prevent a considerable portion from settling out. Rennet or acid will not coagulate it. Sufficient acid or alkali will bring a greater percentage of the flour into solution but as soon as the pH is again adjusted to a point where the product is edible the soybean proteins become insoluble

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in water. This means that instead of a firm curd being formed in the stomach the particles of soybean flour will not adhere together until the acidity of the stomach has increased considerable. In the meantime a large part of the flour has been washed into the abomasum by the water ingested and by the peristaltic movements of the stomach.

• The success of the Chinese in the use of soybean milk in infant feeding (8) (9) raised the question of its adaptability for calf feeding. As a result we became interested in determining the influence of soybean flour on the gastric mechanism of calves.

<center>EXPERIMENTAL</center>

Both calves with Pavlov pouches and calves with gastric fistulas were used in these determinations (Table II), which were conducted in three series as follows:

<center>TABLE II</center>
<center>*Data on calves used in trials*</center>

CALF NO.	BORN	BREED	SEX	DATE WHEN USED IN TRIAL			
				Series I	Series II	Series III	
				12hour experiment (42 trials)	Continuous experiment (49 trials)	16 hour experiment (56 trials)	Acidity curves (44 trials)
				1934	1934	1935	1935
47U	2/14/34	Guernsey	Male	4/4–6/6			
47Y	2/26/34	Holstein	Male	4/4–7/5	7/15–7/28		
47A1	3/6/34	Holstein	Male	4/8–6/6			
47A2	3/7/34	Br. Swiss	Male	6/8–7/2	7/15–7/28		
47A11	6/14/34	Holstein	Female		7/19–7/28		
47A12	6/14/34	Holstein	Female		7/15–7/28		
47A13	12/22/34	Holstein	Female				9/19–11/17
47A14	12/22/34	Holstein	Male				9/19–10/12
47A30	9/19/35	Holstein	Male			10/12–11/13	
47A31	9/19/35	Guernsey	Male			10/15–11/10	
47A32	9/19/35	Guernsey	Male			10/19–11/23	
47A34	9/23/35	Br. Swiss	Male			10/12–11/20	
1306	1/15/35	Ayrshire	Male				9/19–11/17
1344	7/4/35	Holstein	Male			9/15–11/23	

Series 1. A series of twelve-hour trials were run using a test meal of soybean gruel, then a test meal of whole milk. One liter each of the foods to be tested was fed and the effect determined by measuring the rate of secretion, by half-hour intervals, of gastric juice into the Pavlov pouch. A modification of the Dragstedt cannula (2), Fig. 1, was used for collecting the gastric juice.

Series 2. Trials were run for 14 days in which whole milk and soybean gruel were compared in the same manner as in series 1 except that the animals were fed from 3 to 4 pounds per meal (depending on the age of calf)

every 8 hours and the gastric juice collected continuously. The calves were fed soybean gruel for seven days following which they were changed to a similar amount of whole milk and data collected for another seven days.

Series 3. The third series of trials was divided into two parts. (Part 1.) The test meal of one liter of skimmed cows' milk or one-half liter of "fortified" soybean gruel (described below) was fed to calves with Pavlov pouches with the volume of gastric secretion being determined at half-hour
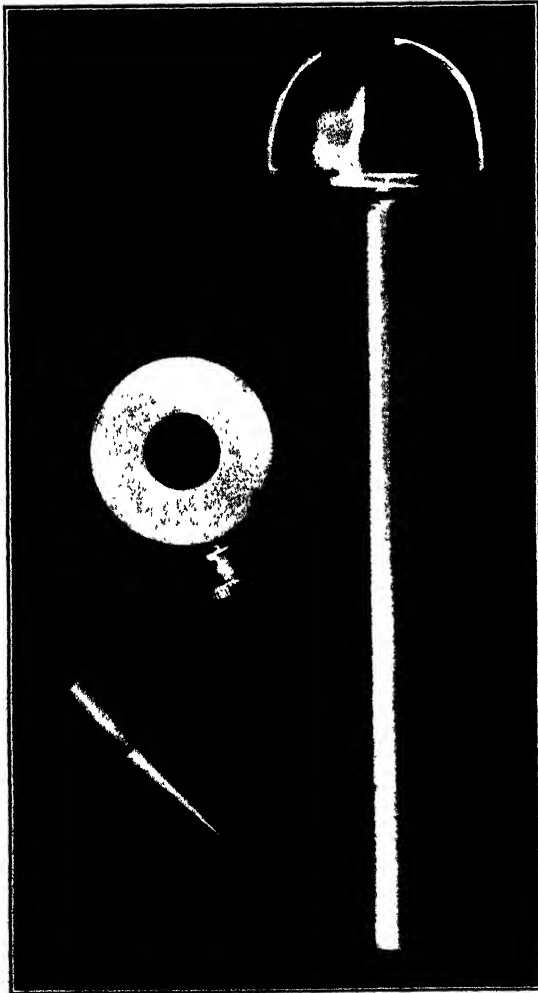

FIG. 1. GASTRIC CANNULA USED IN COLLECTING GASTRIC JUICE FROM PAVLOV POUCH OF CALVES.

intervals. The calves were fed on oatmeal for 12 hours and then fasted 12 hours prior to the feeding of the test meal so that all milk curds would be digested. (Part 2.) Similar meals were fed calves with rumen fistulas. The milk was passed directly to the abomasum by a rubber tube extending through the fistula and the reticulo-omasal and omasal-abomasal orifices. A stomach tube was then inserted in a similar manner so that the weighted end rested on the floor of the abomasum. The upper end was threaded through the plug closing the rumen and connected to a 10 cc. Leur syringe so that samples of gastric juice could be removed at hourly intervals for analysis. The gastric contents were filtered and one cc. of the filtrate titrated with N/100 NaOH. Töpfers reagent and phenolphthalein were used as indicators to determine free and total acidity.

The soybean gruel used in series 1 and 2 was made by stirring soybean flour into warm water at the rate of 1 part flour to 9 parts warm water. The flour was made from hulled beans which were ground, bolted and part of the oil extracted. The analyses are given in table 1. The ''fortified'' soybean gruel, used in the third series consisted of one-third skim milk solids (as skim milk) and two-thirds soybean flour, with water to make a mixture containing 20 per cent dry matter. Eight cc. of a 40 per cent solution of calcium chloride were added to each liter of this milk since milk will not coagulate normally after the addition of soybean flour.

The whole milk used in the 12-hour trials was from one cow in the College herd and had a fat content of 3.1 per cent and a curd tension of 95 grams. The whole milk used in the continuous trial was from another cow in the College herd having a fat test of 3.0 per cent and a curd tension of 82 grams. Skim milk from the former cow was used as a check in the 16-hour trials, as well as a milieu for the soybean flour.

RESULTS

Series 1. Forty-two trials were run in which whole milk was compared with soybean gruel (Table III).

TABLE III

Number of 18-hour trials with calves fed test meals of whole cow's milk and soybean gruel

CALF NO.	COW'S MILK	NUMBER OF TRIALS	SOYBEAN GRUEL	NUMBER OF TRIALS
47U	(mouth fed)	9	(mouth fed)	3
47A1	(mouth fed)	8	(mouth fed)	3
47Y	(mouth fed)	9	(mouth fed)	5
47A2	(fistula fed)	2	(fistula fed)	3
Total		28		14

Figure 2 shows the average results of these trials for each calf. There was a tendency for the gastric juice to be trapped within the pouch even

with the special crown provided for the cannula. Even when exerting a slight amount of traction on the cannula it would sometimes be necessary to force a little air into the pouch to allow the escape of the gastric juice. In spite of these precautions more or less fluctuation persisted. The authors feel that this secretion was not due to psychic stimulation but that the more complete emptying of the pouch probably resulted from the calf's movements. One of the predominating characteristics of these data which should
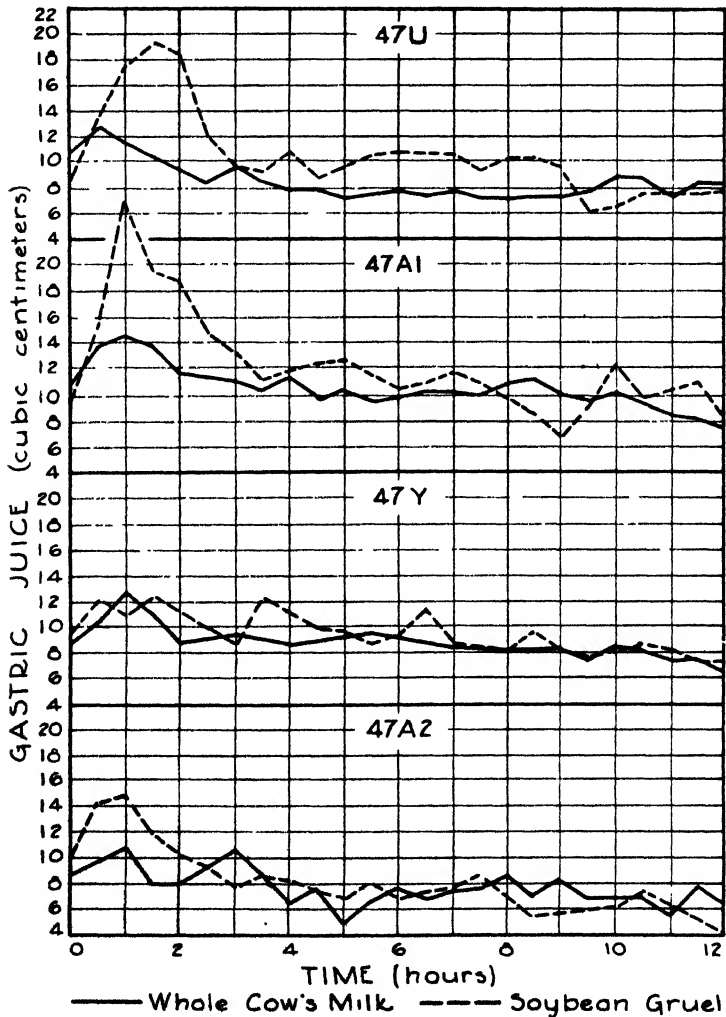

FIG. 2. EFFECT OF ONE LITER OF MILK AND SOYBEAN GRUEL WHEN FED SEPARATELY ON GASTRIC SECRETION OF CALVES.

be noted was the comparatively brief rises in rate of gastric secretion after the ingestion of each test meal. The rate of gastric secretion then fell to its comparatively constant level of secretion which persisted even after it was proved, by exploration through a gastric fistula, that the stomach was empty.

In each instance it will be noted that the calves secreted slightly more total gastric juice during the 12-hour observation periods when fed soybean gruel than when fed whole milk. In that soybean gruel does not form a hard coagulum it leaves the stomach more rapidly than the curd from milk. For this reason the gastric juice for the 12 hours may not reflect the same part of the digestive process in both instances. It is therefore rather difficult to interpret the results. The greater initial secretion with soybean gruel may be caused by the escape of some of the more soluble constituents of the soybean flour with the water. These products may have a greater stimulating action on gastric secretion than the serum which escapes following coagulation of the milk. On the other hand, it is possible that some of the insoluble material in the soybean gruel escapes into the duodenum where it is rapidly broken down by the intestinal fluids and absorbed, thus stimulating gastric secretion.

In spite of the fact that the soybean gruel causes a greater secretion of gastric juice the calves do not grow as rapidly on it as on whole milk. The feces are foul as if the food is only partially digested and the calves scour very easily. This would tend to confirm the suggestion that the too rapid escape of the soybean flour from the stomach may overload the intestine with incompletely digested products.

It should be remembered that the digestion of cow's milk proceeds at a comparatively slow rate due to the formation of a curd immediately upon the passage of the milk into the stomach. The retention of the milk in the stomach is not wholly dependent upon this coagulation, however, for Mortenson (5) found that a test meal of autoclaved milk, which would not curdle with rennet, remained in a calf's stomach for at least two hours. Perhaps even extremely soft-curd milk is retained in the calf's stomach sufficient time for some digestion to take place.

Series 2. Curves showing the results obtained when four calves were full-fed three times a day on soybean gruel and whole cow's milk, are shown in Figure 3. For this series calves 47Y and 47A2 (same two calves used in series 1) were fed by tube through their fistulas. Two other calves, 47A11 and 47A12, were prepared with Pavlov pouches only and consequently were pail fed. These calves were handled in the same way as in the previous experiment except that the calves were fed every eight hours. The two older calves 47Y and 47A2, were fed four pounds per feed while the two younger calves, 47A11 and 47A12, were given three pounds per feed. The feeding hours were 5:00 a. m., 1:00 p. m., and 9:00 p. m. It will be noted from these results that there was little difference in the amount of gastric
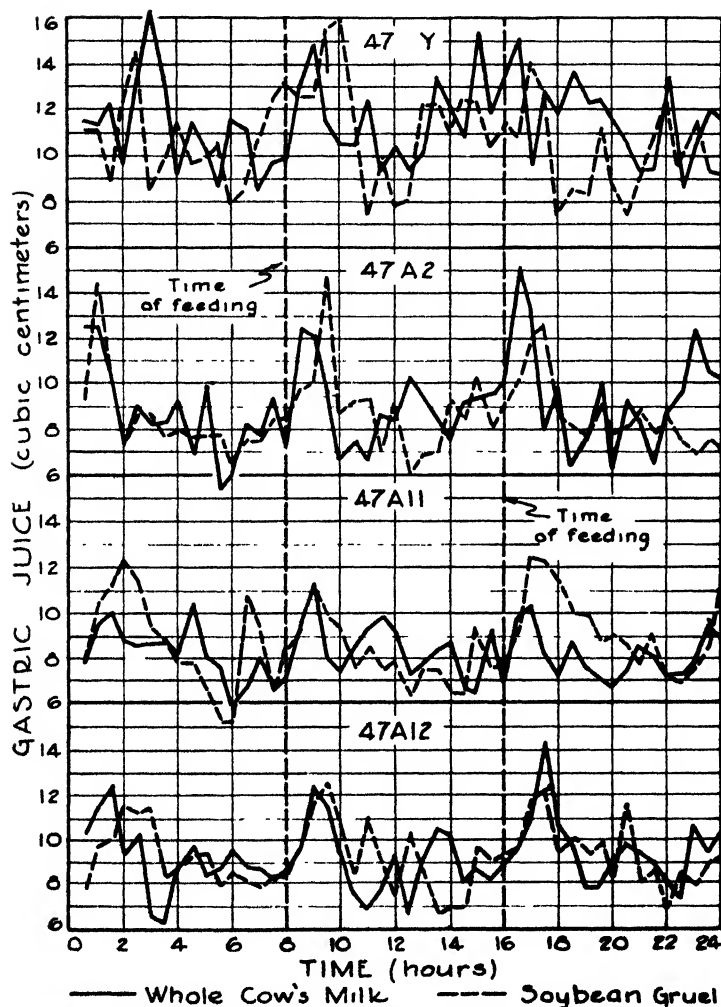
FIG. 3. EFFECT ON GASTRIC SECRETION OF CALVES FED MILK AND SOYBEAN GRUEL (SEPARATELY) EVERY EIGHT HOURS DURING SEVEN-DAY PERIODS.

juice secreted as a result of the two different feeds. Apparently from these data one can conclude that the longer period with milk caused the conflicting results with series 1.

Series 3, Part one. The results of feeding fortified soybean gruel (soybean flour mixed with skim milk and sufficient water to bring to 20 per cent solids, plus the needed $CaCl_2$ to cause the skim milk to coagulate with rennin *in vitro*) and skim milk are shown in figure 4. In these trials one-half liter of the soybean milk was used instead of the customary liter because of its
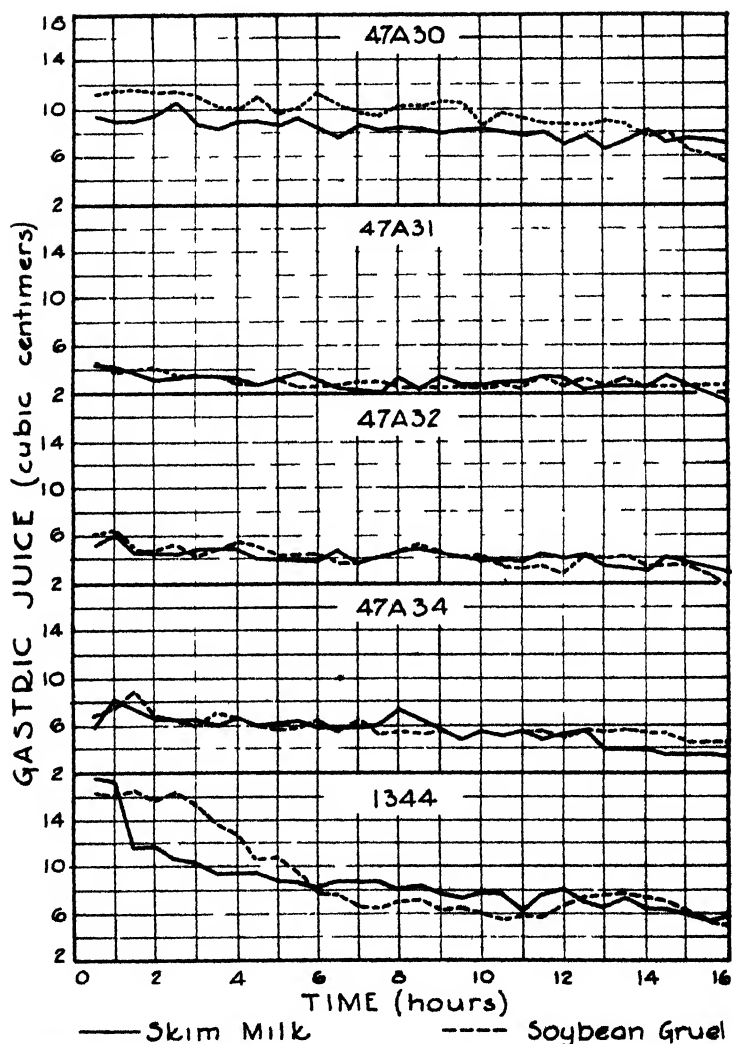
FIG. 4. EFFECT OF SKIM MILK AND "FORTIFIED" SOYBEAN GRUEL WHEN FED SEPARATELY ON GASTRIC SECRETION OF CALVES.

higher solids content. The solids content of the two meals were thus approximately equal but the water ingested with skim milk was approximately double that in the soybean gruel. Five rather young calves were used in these trials (Table II). The amount of gastric juice secreted was again quite comparable on the two types of feed.

Series 3, Part two. The average amount of free and total acid are shown in figure 5. No significant difference between the two types of feed are to be noted. The maximum total acidity occurs between the fourth and fifth hour. The free acid is very limited at any time, rarely any being found until the second hour. The original pH and the acid binding properties of the two feeds are doubtless of importance. The pH of the various milks used in the different series are given in Table IV.
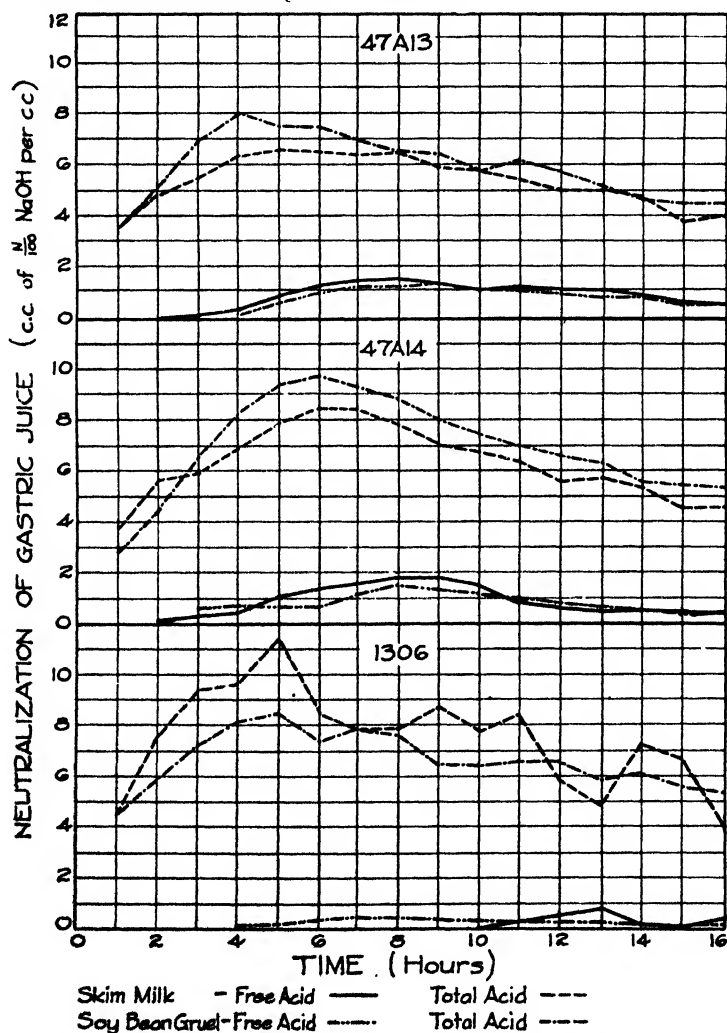

FIG. 5. EFFECT OF SKIM MILK AND ''FORTIFIED'' SOYBEAN GRUEL WHEN FED SEPARATELY ON THE FREE AND TOTAL ACID OF THE GASTRIC JUICE.

TABLE IV

Hydrogen ion potential of soybean gruels and skim milk

MILKS	PH
Soybean flour in water	6.42
Fortified soybean gruel	6.10
Skim milk	6.70

DISCUSSION

This experiment was begun in the hope of devising a simple milk substitute for calf feeding. Realizing that the physical properties of the food exert a marked influence on its utilization by the calf it was decided to study the digestive processes after feeding soybean gruel rather than depending upon growth data.

When individual trials are run, such as are presented in series 1, it is necessary to empty the rumen and keep the calf on a liquid diet for three days. Twenty-four hours before the trial is started the calf is given a liquid gruel which will not coagulate and will disturb digestion a minimum amount, such as oat meal gruel. One liter has been used as the test meal in order that all results may be as near comparable as possible. However, as the calf grows, the meal becomes comparatively smaller. For this reason the milk and soybean trials were alternated and the results averaged. The twenty-four hour preparatory period plus the twelve to sixteen hour test period makes it necessary to full feed the calf on milk for at least three days before running a second trial. For this reason the trials cover a longer period than was desired. During this time not only the relative and actual size of the different compartments have changed but perhaps the physiological processes have been altered, such as the amount of rennin secreted. Environmental factors, especially temperature, and the physical well being of the calf including appetite are important factors in modifying the rate of gastric secretion. The absence of the degradation products of the paunch as well as the saliva ingested may be of importance. However, these were comparable for the two types of feed used. The results with one calf can only be compared in a general way with the results with another calf in that the size of the Pavlov pouch, the region of the stomach included and the injury to extrinsic nerves will influence the total amount of juice secreted. Acidity curves, using the filtrate from the gastric contents, would aid in interpreting the secretory processes. However, it is impractical to attempt to place a stomach tube in the abomasum by way of the mouth due to difficulty of holding it *in situ*, salivation, and the anatomical arrangement of the esophageal groove. Then, too, unless the rumen was emptied manually before the trial was begun there would be a constant shift of the products from one stomach to another.

The first trials were carried out with whole milk in that only a part of the oil had been removed from the soybean flour. The amount of fat present in either the milk or the soybean gruel probably did not materially modify the length of the digestive period (3). The exact reason for the marked increase in the rate of gastric secretion one hour after feeding soybean gruel is not known. It would appear, however, that a portion of the gruel probably escaped into the duodenum. If soluble products were originally present in the soybean flour which had a secretagogic effect the rate of secretion should have risen more rapidly than it did. This would indicate that the gruel underwent a certain amount of digestion before secretagogic products were available for absorption. Apparently the fluids escaping from the coagulated milk act somewhat more quickly but with less gastric stimulating power. Though these trials also indicate a somewhat higher total gastric secretion on soybean gruel, the lack of confirmatory results in the next two series would indicate that the digestion of the milk was not complete at the end of twelve hours.

The results of individual trials show considerable variation in the amount of gastric juice secreted due probably to the trapping of the gastric juice within the pouch. There is no evidence to indicate that the actual gastric secretion varied in this manner from period to period. The fact that more uniform amounts were secured from some calves than from others would tend to support this conclusion.

During the latter part of the first series and through the entire period of the second series the temperature, even within the barns, was almost intolerable. This extreme heat exhausted the calves so much that blocks of ice were placed in the pens and a fan used to circulate the air. In spite of this precaution there was much to be desired in the way of optimum conditions for the maximum response from feeding. The increase in the average hourly rate of gastric secretion by calves 47Y and 47A2 in series 2 over that in series 1 can probably be accounted for by the larger food intake rather than by the increasing age of the animals.

The solids content of the gruel was increased in series 3 and the milk added as a diluent so that all of the soybean flour might be retained in the abomasum until it could be exposed to the action of the gastric juice. The lack of a high initial secretion on the soybean gruel in the last series may be due to the slower emptying of the stomach. Though Tobler and Bogen (7) found that increasing the amount of milk fed to dogs from 100 to 200 cc. increased the length of the digestive period from 145 to 240 minutes, the effect of the smaller volume in the case of the gruel (one-half liter) would be less serious since the solids content of the two meals remained approximately the same.

The amount of free and total acidity obtained during the second part of series 3, while interesting, throws little light on the problem being investigated. As previously mentioned (3) acidity curves are not a satisfactory criteria for determining the length of the digestive period in calves. The

difference in the amount of free and total acid when milk and soybean gruel was fed is insignificant.   The fact that the free acidity did not increase on the "fortified" soybean gruel would tend to indicate that a considerable part of the test meal remained in the stomach for several hours.

The amount of $CaCl_2$ included in the "fortified" soybean gruel should have produced no injurious effect upon the gastric mucosa.   However, the chloride ions did increase the acidity of the mixture as well as aid in the coagulation of the milk.   Whether the calf would respond by an increase in rate of growth on the "fortified" soybean gruel over the soybean flour water mixture was not determined.

SUMMARY

A soybean gruel made by mixing one part of soybean flour with nine parts of water was compared with whole and skim milk for calf feeding.   A "fortified" soybean gruel in which skim milk solids made up one third of the total solids of the gruel was also tried.   The results were analyzed in terms of (1) cubic centimeters of gastric juice collected by half hour periods from Pavlov pouches and (2) free and total acidity of the gastric contents. The amount of gastric juice secreted was approximately the same in both the milk and the soybean gruel trials.   The data tend to confirm the belief that the soybean flour-water mixture leaves the stomach more rapidly than the milk curd.   The data do not furnish the answer to the question of why calves do not thrive on a soybean gruel but they do indicate that it is not due to a diminished gastric secretion.

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A SIMPLIFIED PROCEDURE FOR CALCULATING WEIGHTS OF MILK TO THEIR ENERGY EQUIVALENT IN MILK OF DIFFERENT FAT CONTENT IN ACCORDANCE WITH THE GAINES[1] FORMULA

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The formula introduced by Gaines (1) for the calculation of milk yields to their energy equivalent in terms of 4 per cent milk has come into widespread use. Overman and Gaines (2) have presented additional evidence further establishing the accuracy of the formula. The manner in which the formula is commonly stated,

$$**F.C.M. = 0.4\,M + 15\,F,$$

while seemingly very simple, requires at least four distinct operations and recordings to complete the computation, when the weight of milk and its fat percentage are the known terms.

While using this formula it occurred to the writer that there must be a simpler method of obtaining these results. The method arrived at was as follows: The value of 100 pounds each of milk testing, 2, 3, 4, 5, 6, and 7 per cent fat was calculated to its energy equivalent in 4.0 per cent milk by the Gaines formula. The value for 4 per cent milk was of course 100, since that is the base of the system. The values for 2, 3, 5, 6, and 7 per cent milk, were respectively, 70, 85, 115, 130 and 145. By moving the decimal point two places to the left the factor was obtained by which weights of milk of these respective fat contents may be multiplied to indicate in each case the energy equivalent amount of 4.0 per cent milk, expressed in the same weight unit. If these values are plotted as a curve they will be found to lie in a straight line. It follows that a given increase as 1.0 per cent in fat content corresponds to the same increase in energy content of the milk at all places on the curve. When 4.0 per cent milk is the base each change of 1.0 per cent in fat contnt from that level corresponds to a 15 per cent change in energy value of the milk; or, each tenth of one per cent change in fat content corresponds to a 1.5 per cent change in energy value, the corresponding conversion

** Gaines gives the following explanation of these symbols and expressions:

F.C.M. = Milk energy in terms of normal whole cow's milk of 4.0 per cent fat content.

M = Weight of milk; F = Weight of fat, all expressed in the same unit of weight. One pound of F.C.M. equals 340 calories, or, E (in calories) equals 340 F.C.M. lb.

factor for 0.1 per cent change in fat content being 0.015. The simplified method of converting a given weight of milk of other fat content to its energy equivalent weight of 4.0 per cent milk is then as follows: The deviation of the fat content from 4.0 per cent is noted in terms of tenths of one per cent. This deviation is multiplied by 0.015. In case the deviation is positive or the milk in question is above 4.0 in fat content the product is added to 1.0 to obtain the desired conversion factor. If the deviation from 4.0 per cent fat content is negative the product of its multiplication by 0.015 is subtracted from 1.0 to obtain the desired factor.

These processes are so simple that they may usually be carried out mentally but in case one objects to too much mental arithmetic, the factors may conveniently be arranged in tabular form as presented in Table 1.

TABLE 1

Factors for converting weights of milk of other fat content to their energy equivalent weight of 4.0 per cent milk

*f	.0	.1	.2	.3	.4	.5	.6	7	8	.9
2	.700	.715	.730	.745	.760	.775	.790	.805	.820	.835
3	.850	.865	.880	.895	.910	.925	.940	.955	.970	.985
4	1.000	1.015	1.030	1.045	0.060	1.075	1.090	1.105	1.120	1.135
5	1.150	1.165	1.180	1.195	1.210	1.225	1.240	1.255	1.270	1.285
6	1.300	1.315	1.330	1.345	1.360	1.375	1.390	1.405	1.420	1.435
7	1.450	1.465	1.480	1.495	1.510	1.525	1.540	1.555	1.570	1.585

* f = fat per cent.

Each of the numerical values in this table is a solution of the expression $(.4 + 0.15 f)$ for the corresponding value of f; for use in the formula,

$$F.C.M. = M (.4 + 0.15 f)[1]$$

which is an alternate, but little used statement of the Gaines formula.

Table 1 is carried only to 0.1 per cent intervals of variation in the percentage fat content. If so desired the values may easily be interpolated to 0.01 per cent fat since the intervals are proportional throughout the range. It seems doubtful to the writer, however, whether the accuracy of the data on which the formula is based would justify so minute an interpretation of the results.

We have since found that Brody and Ragsdale (3) have published a similar though less complete table for use in connection with other data in determining the comparative efficiency of large and small cows.

Multiplication of the weight of milk of any natural fat content by the appropriate factor will give the energy equivalent weight of 4.0 per cent milk in terms of the same unit of weight. It should be pointed out that this relationship will not hold in the case of milk whose fat content has been artificially altered in any way. The results obtained by this method are identical with those obtained by using the customary statement of the Gaines

formula except as either may be slightly affected by the dropping of incompleted decimals.

It may sometimes be desirable to calculate the equivalent amount of milk to some other base than 4.0 per cent. The Gaines formula expresses the energy value of milk of any fat content. It should therefore be possible to compute similar factors or increments for converting milk of any given fat content to its energy equivalent amount of milk of any other basic fat content. Gaines (1) has suggested the foregoing use of his formula but did not give a detailed procedure.

One suitable procedure for this calculation follows: It may be recalled or noted from Table 1 that there is a constant difference of 0.15 in the factors for each per cent of difference in fat content. This difference of 0.15 in the factor represents the energy associated with a 1.0 per cent increase in fat content. It remains constant for all values of f.

If the value of 0.15 (A) is divided by the factor from Table 1 representing the energy value of milk of a definite fat content (B), the quotient will represent the energy value accompanying a 1.0 per cent fat increase A, in terms of the energy value of the milk selected, (B). Thus, 0.15 divided by 0.85 the factor for 3.0 per cent milk equals 0.1765 indicating that in the case of 3.0 per cent milk each per cent of increase in fat content increases the energy value of the milk by 0.1765 or 17.65 per cent.

Table 2 has been prepared showing corresponding values for 1.0 per cent increase of fat content in terms of milk ranging from 2.0 to 7.0 per cent fat content by 0.5 per cent intervals.

TABLE 2

FAT CONTENT OF MILK	VALUE OF 1 0 PER CENT INCREASE IN FAT CONTENT AS A PERCENTAGE OF THE ENERGY VALUE OF THIS MILK
2.0	21.43 per cent
2.5	19.34
3.0	17.65
3.5	16.22
4.0	15.00
4.5	13.95
5.0	13.04
5.5	12.24
6.0	11.54
6.5	10.91
7.0	10.35

If desired a table similar to Table 1 could be constructed based on any one of these levels of fat content and the corresponding percentage of increased energy value brought about by 1 per cent increase in fat content, as shown in Table 2.

The numerical value of the factor representing a given increase in fat content is not the same in different parts of this table; therefore the values for milk intermediate in fat content between those shown will need to be obtained by direct calculation rather than by interpolation of the values given in Table 2. Each value given in Table 2 gives the change in energy value of the milk for 1.0 per cent change in fat content. Values for 0.1 per cent change may be found by the relocation of the decimal point.

Some question has arisen as to the desirability or usefulness of figures such as presented in Table 2. In this connection it should be recalled that a large proportion of the milk sold commercially is paid for with reference to a 3.5 per cent rather than a 4.0 per cent basic fat content and that either 3 per cent or 3.5 per cent are the lower legal limits of fat content of milk in many states. Producers, dealers and consumers alike should be interested in such simple and accurate information regarding the relation of additional fat content to the food or energy value of the milk they sell or purchase.

The Gaines formula was introduced and has been used chiefly for reducing the production of different cows to common terms to facilitate comparison between them. For this particular purpose conversion to 4.0 per cent milk is convenient and as suitable as any other common measure. However, as suggested above this is by no means the only field of usefulness for the formula, once its significance is better understood. The data presented in Table 2 may be considered as a step in this direction. The energy values of milk of different fat content as calculated by this method agree well with actual calorimetric determinations as reported by Overman and Sanmann (4) and Savini and Garzia (5).

A simplified procedure has been described for the use of the Gaines formula in comparing milk yields. Other uses for the formula are also suggested and a table presented which will facilitate its use for these purposes

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OXIDIZED FLAVOR IN MILK

IV. STUDIES OF THE RELATION OF THE FEED OF THE COW TO OXIDIZED FLAVOR[*]

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Apparently the earliest work dealing with the relation of the feed given cows to oxidized flavor development in the milk was done by Kende (5) in 1932. He reported that oleaginous (oxidized) flavor seems to occur only during the winter, and also that green feed as well as the fresh hay produced from it contain considerable amounts of reducing substances which tend to prevent oxidized flavor development or lessen its intensity, whereas certain so-called industrial feeds, especially sliced beets, lack these reducing substances and seem to favor oxidized flavor development in the milk from cows to which they are fed. Mayer (6) has found that the tallowing (oxidized flavor) action of beet forage can be prevented by the addition to the ration of corresponding amounts of fresh alp hay, which supports Kende's belief that fresh forage contains reducing substances which pass to the milk and prevent oxidized flavor development.

It was shown by Kende, and substantiated by Guthrie and Brueckner (4), that some milks develop oxidized flavor spontaneously (that is, without the addition of copper or iron). Kende attributes this effect to the absence of reducing substances in the feed and consequently in the milk.

The foregoing review indicates that the feed given the cow plays an important rôle in controlling the susceptibility of the milk to oxidized flavor development. In order to learn more concerning the effect of the feed of the cow on oxidized flavor development in milk the experiments herein reported were planned and conducted. These experiments include: a weekly study of the susceptibility of the mixed milk from certain cows in the herd, which were fed and cared for by the methods used in the management of the regular herd, throughout one year; a frequent study of the susceptibility of the milks of all individual cows in the Experiment Station herd, with the exception of those cows on certain special feeding experiments, throughout more than a year; a study of the susceptibility of the milks of nine individual cows, which were alternated between dry feeding and dry feeding

plus pasturing regimes; and, studies of the effects of feeding vitamin C-rich substances, and of feeding vitamin C itself, on the susceptibility of the milks of three individual cows.

Susceptibility of Mixed Milks Throughout a Year

In carrying on this study it would have been desirable to have taken samples of mixed milk from the entire herd, but a number of the cows were on special feeding experiments, which warranted the exclusion of their milks. Also, at the time the study was begun, the condition of the cooler and strainers at the farm was such that exposed copper surfaces made it impossible to avoid copper contamination. For this reason the mixed milk used in this experiment was from the first cows milked each time, excepting those on special feeding experiments, and the milk was neither strained nor cooled at the barn. When ten gallons of milk had been obtained the collection of milk for sampling was stopped and the milk was brought to the laboratory for sampling within the hour. The milk of Jersey and Guernsey cows was used for the sample and an average of five to eight cows was usually required to obtain sufficient sample.

Seven quart samples were saved in quart milk bottles and immersed in ice water. One of these samples served as a control and received no treatment while to the six remaining samples 1.3, 2.6, and 3.9, parts per million of copper and 31, 62, and 93 parts per million of iron were added, respectively, from solutions of either copper sulphate or ferric chloride. The samples thus prepared were stored at approximately 40° F. for three days, after which they were tasted to determine the intensity of the oxidized flavor developed. This procedure was repeated once each week throughout one year. No samples were pasteurized in conducting this experiment.

The significant results are recorded in Table 1. Since 2.6 and 3.9 parts per million of copper did not increase the intensity of the oxidized flavor developed these results were omitted from the table.

The outstanding facts shown by these results appear to be that (1) the mixed milk never developed oxidized flavor when no copper or iron was added to it; (2) that much more iron than copper is required to produce oxidized flavor and, (3) that the changing of the cows from dry feeding to a dry feeding plus pasturing regime caused the milk to become nonsusceptible to oxidized flavor development. Weekly studies show that the change occurred very soon after the cows were given pasture. The results show also that the milk produced in December, 1934, was much more susceptible than the milk produced in December, 1935. It would seem that the variation in the susceptibility of the milk toward oxidized flavor development throughout the year may be explained fairly satisfactorily on the basis of variations in the feed of the cows. Apparently pasture grasses

TABLE 1

Effect of dry feeding versus pasture supplemented by dry feeding on the susceptibility of non-pasteurized milk to oxidized flavor development

PERIOD	FLAVOR OF RAW MILK SAMPLES AFTER 3 DAYS' STORAGE AT APPROXIMATELY 40° F.				
	Added Cu in p.p.m.		Added Fe in p.p m.		
	None	1.3	31	62	93
	Cows on dry feed				
12/6/34–4/11/35	—	4	—	2	3
	Cows pastured -- one-half day beginning 4/15/35—full day 4/24/35				
4/25–11/13/35	—	—	—	—	—
	Cows on dry feed after 11/17/35				
11/21–12/11/35	—	—*	—	—	—

Note: Samples were taken each week except during long periods of no change when they were taken at two-week intervals.

* The use of 2.6 p.p.m. of added copper gave a very slight oxidized flavor.

Meaning of symbols: —, no oxidized flavor; 1, very slight oxidized flavor; 2, slight oxidized flavor; 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor; 5, pronounced oxidized flavor; 6, very pronounced oxidized flavor.

contain one or more substances which pass to the milk and act in such a manner as to retard or prevent oxidized flavor development even though copper or iron is added.

Susceptibility of the Milks of Individual Cows

During much of the same period in which the study of the susceptibility of mixed milk just described was being conducted, experiments studying the susceptibility of the milk of each individual cow in the herd were being carried on also. These studies were made at varying intervals in order to have information as to the susceptibility of the individual animals for use in connection with other phases of the oxidized flavor work, and they also serve to show to some extent the effect of the food on susceptibility.

In each case one person, charged with the responsibility of taking these individual samples, remained at the station dairy farm during the period when the evening milking was being done and supervised the sampling. The milk was drawn into aluminum buckets, and four pint-bottles were filled with the milk of each cow. As soon as all the samples were taken they were brought to the laboratory. To each of two of the pint samples of each cow's milk 1.3 parts per million of copper were added in the form of copper sulphate solution whereas nothing was added to the two other samples. Of the samples from each cow, one containing the added copper and another containing no added copper were stored at approximately 40° F., whereas the duplicates of these samples were pasteurized at as near 143° F. as possible by immersion of the bottle in hot water. The pasteurized samples, after cooling were stored along with the non-pasteurized samples. After a three-day storage period the samples were tasted. Six

studies were made at the beginning of this experiment from which samples containing added copper were omitted, and in one of these studies only pasteurized milk was examined, because at that time it was intended to determine only the extent of spontaneous oxidized flavor development.

TABLE 2

Seasonal variation in the susceptibility of milks of individual cows to oxidized flavor development

DATE	*PERCENTAGE OF MILKS EXAMINED THAT SHOWED OXIDIZED FLAVOR IN			
	Raw milk		Pasteurized milk	
	No copper	1.3 p.p.m. copper	No copper	1.3 p.p.m. copper
Cows on dry feed				
2/19/35			31	
3/15/35	6		29	
4/13/35	0		7	
Cows pastured 6 hours per day beginning 4/15/35				
4/22/35	0		10	
Cows pastured day and night beginning 4/25/35				
4/29/35	0		3	
5/6/35	0		3	
5/13/35	0	7	0	0
5/27/35	0	11	0	4
6/11/35	0	18	4	25
6/17/35	0	25	0	29
7/2/35	0	13	0	3
7/15/35	0	7	0	10
Pasture supplemented by silage beginning 7/24/35				
7/29/35	0	6	0	9
8/12/35	0	6	0	3
8/26/35	0	3	0	19
9/16/35	0	3	0	6
9/30/35	0	3	0	9
Full winter ration supplemented by pasture beginning 10/15/35				
10/15/35	0	6	0	26
Cows stabled at night beginning 10/25/35				
10/28/35	0	0	0	26
11/11/35	0	0	0	17
Cows received no pasture supplement beginning 11/18/35				
11/29/35	0	6	0	27
12/12/35	0	9	6	12
12/23/35	0	5	0	41
1/7/36	missed	3	0	missed
1/13/36	6	36	9	58
1/27/36	0	13	6	45
2/10/36	0	13	0	53
2/17/36	0	16	0	22
2/24/36	0	29	0	50
3/2/36	3	35	3	62
3/9/36	0	38	0	24
3/16/36	0	18	0	10
3/23/36	0	31	0	31
3/30/36	5	49	5	47
4/6/36	0	36	14	19
4/12/36	0	23	2	5
4/20/36	0	36	0	21
Cows on pasture beginning 4/22/36				
5/6/36	0	3	0	0

' Smallest number of cows studied at any time, 27; largest number studied, 43.

The results of this work, recorded in Table 2, indicate, as did the experiments with mixed milk, that the feed of the cows has a very pronounced effect on the susceptibility of the milk to oxidized flavor development. The feeding regime also is closely related to the tendency for spontaneous development of oxidized flavor. Thus, during February and March, 1935, and until pasturing was begun, a considerable percentage of the milks to which no copper had been added developed oxidized flavor. During the pasturing season practically no spontaneous development of oxidized flavor occurred and the susceptibility of the milks, as tested by the addition of copper, was reduced greatly. It would seem that the feeds used during February and March, 1935, favored the spontaneous development of oxidized flavor to a considerably greater extent than those used during the same months of 1936. It is probable that the hay fed during these months of 1936 contained more reducing substances than that fed during the same months of 1935.

The Effects of Reversals Between Dry- and Pasture-Feeding Regimes

The results of the foregoing experiments indicated the desirability of conducting a more carefully controlled experiment studying the effects of pasture on the susceptibility of milk to oxidixed flavor development. Accordingly eight cows were selected and placed on a reversal feeding experiment just before the beginning of the pasture season of 1935. Another cow, No. 384, that freshened after the start of the pasture season, was placed on the experiment at that time. The feeds used for the dry feeding regime consisted of yellow cornmeal, wheat bran, cottonseed meal, bone meal, and common salt in the grain mixture with first and second cutting alfalfa hay as the roughage. When the cows were on pasture the supplementary dry feeds consisted of the same grain mixture.

It was planned at first to keep the cows on the experiment in two groups and to reverse all the animals of one group from dry feeding to pasture feeding regimes or *vice versa* at one time. However, it became evident soon that the cows differed greatly in their tendencies to produce susceptible or non-susceptible milks under identical conditions of feeding and for this reason reversals were made individually whenever complete susceptibility changes occurred. In so far as possible, reversals from the dry-feeding to the pasture-feeding regimes were made whenever the milk became susceptible to oxidized flavor devlopment and the opposite reversals were made whenever the milk became non-susceptible. The milk of one cow, No. 365, did not lose its susceptibility entirely during a long pasture-feeding regime. However, the intensity of the flavor decreased during the pasturing regime and further pasturing was prevented because she became dry.

Determination of the susceptibility of these milks to oxidized flavor development was made by tasting the raw and pasteurized milk of each cow, both with and without added copper after a three-day period of storage at approximately 40° F. The method of preparing the samples was the same as that described for the preceding experiment in which the susceptibility of the milks of individual cows was determined. During the first two weeks of the experiment the milk of each cow was tested for susceptibility one day each week, but thereafter it was studied on three consecutive days each week.

Unfortunately the experiments reported in a previous paper of this series (2) had not been done when this work was started, and consequently the authors were not aware of the importance of the addition of copper after pasteurization rather than before when studying the susceptibility of milk to oxidized flavor development. In this work all pasteurized milks contaminated with added copper received the copper before pasteurization. For this reason the results with the raw milk probably are of greater significance than the results with the pasteurized milk in this particular study.

The results of this work, recorded in Table 3, indicate, as did the foregoing experiments studying susceptibility, that pasture has a pronounced effect on the susceptibility of the milk to oxidized flavor development.

Considerable variation was found in the susceptibility of the milks of the individual cows on this experiment. The milks from six cows, Nos. 318, 367, 368, 371, 374 and 384, were rendered non-susceptible readily by the pasture-feeding regime, whereas the milks from the three remaining cows, Nos. 364, 365, 379, were affected less readily by pasture. Even in the cases of the latter animals the intensity of the oxidized flavor developed after the addition of copper was decreased considerably by the pasturing regime.

In the case of cow No. 379 spontaneous development of oxidized flavor (without the addition of copper) occurred during the dry feeding regime, but ceased almost immediately after she was turned on pasture. Her milk did not lose its susceptibility entirely although she was continued on the pasturing regime for fourteen weeks. At the end of that time she was removed from the herd because of low production. During the latter part of the pasturing period the grass became short and dry because of drouth. Furthermore, this animal was known to be a poor grazer.

The milk from cow No. 365 did not lose its susceptibility entirely at any time during the experiment. However, the intensity of the oxidized flavor diminished considerably during the pasturing regime which followed a period of dry feeding. Because of advancing gestation this cow had to be turned dry, and was discontinued from the experiment.

On the other hand, the milk of cow No. 371 showed the most ready response of any of the cows on this experiment to reversals between dry and

TABLE 3

Studies of the effect of dry feeding versus pasturing supplemented by dry feeding on the susceptibility of milk to oxidized flavor development

WEEKS	1	2	3	4	5	6	7	8	9	10	11	12
Cow No. 318												
Raw milk	?	?	—	—	—	—	—	—	—	—	—	—
Raw milk + 1.3 p.p.m. Cu	?	—	? 2 —	2 2 3	— ? 1	2 2 2	2 2 3	— 3	4 4 2	2 4 —	—	—
Pasteurized milk	?	4	4 2 1	4 2 2	4 2 2	4 — —	3 4 2	2 — 1	4 3 3	1 — —	? 1 2	— 1
Past. + 1.3 p.p.m. Cu	4	?	4 2 1	4 4 4	4 2 4	4 — —	3 4 2	2 — 1	4 4 4	4 3 4	1 1 —	4 2 1
Cow No. 364												
Raw milk	4	4	4 4 4	4 4 4	7 4 4	2 1 4	2 2 4	4 3 3	2 3 2	2 1 —	— 1	2 1 1
Raw milk + 1.3 p.p.m. Cu	4	4	7 3 4	4 4 4	4 4 4	4 4 4	4 4 3	1 2 1	3 1 1	2 3 1	3 3 1	2 2 2
Pasteurized milk	4	4	4 2 1	2 2 2	— 4 4	4 2 2	2 4 4	2 4 2	3 2 7	— 1 —	2 3 2	1 2 2
Past. + 1.3 p.p.m. Cu	4	4	4 —	3 - 3	— ?	— 1 ?	—	— 2	—	2 —	? —	— 1 —
Cow No. 365												
Raw milk + 1.3 p.p.m. Cu	4	4	? — 2	4 — 2	1 3 1	? 1 ?	2 — 1	1 2 —	3 3 1	1 — 1	? — ?	1 1 —
Cow No. 367												
Pasteurized milk	4	4	4 ? 2	2 — 2	— 2	—	—	2	— 1	3 2 —	2 —	? ?
Past. + 1.3 p.p.m. Cu	4	4	2 2 4	4 4 4	1 4 4	4 1 2	1 — —	4 2 2	? 2 2	3 2 1	2 1 1	1 2 1
Cow No. 368												
Raw milk	4	4	2 —	? —	—	—	—	— 2 2	2 1 2	3 1 4	4 2 1	—
Raw milk + 1.3 p.p.m. Cu	4	3	—	—	—	—	—	2 2 1	3 1 7	1 4 2	3 ?	—
Cow No. 371												
Past. + 1.3 p.p.m. Cu	4	4	? ? —	— 3	1 1 —	—	—	2 2 1	4 1 3	4 3 4	? 1	—
Cow No. 374												
Pasteurized milk	?	?	—	—	—	—	? — —	—	3 1 2	4 3 2	1 2 —	—
Cow No. 379												
Raw milk + 1.3 p.p.m. Cu	4	6	5 6 4	4 4 5	5 4 5	4 4 4	5 4 4	5 5 5	4 4 4	4 4 4	5 4 4	4 4 4
Pasteurized milk	—	4	4 4 4	4 2 4	— 2 2	7 2 3	2 — 1	—	4 2 2	1 3 2	3 3 3	3 2 2
Past. + 1.3 p.p.m. Cu	4	—	2 4 2	4 — 4	4 4 5	1 7 ?	2 4 3	3 3 3	—	—	—	—
Cow No. 384												
Raw milk + 1.3 p.p.m. Cu										1 — —	—	—

TABLE 3.—Continued

WEEKS	13	14	15	16	17	18	19	20	21	22	23	24
Cow No. 318 Raw milk	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
Raw milk + 1.3 p.p.m. Cu	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
Pasteurized milk	— —	— —	— —	— —	— —	— —	1 1 —	— —	— —	— —	— —	— —
Past. + 1.3 p.p.m. Cu	— —	— —	— —	— —	1 1	1	—	—	—	—	—	—
Cow No. 364 Raw milk	4 4 1	1 2 2	1 9 1	— 1 1	— 1 —	— —	— ? —	3 3 3	1 3 2	1 9 3	1 — 2	— —
Raw milk + 1.3 p.p.m. Cu	2 1 1	1 1 —	1 2 —	— 1 1	— 1 —	— —	4 —	1 1 —	1 — ?	1 — 2	1 — 1	— —
Pasteurized milk	1 1 2	1 2 1	2 1 1	9 1 2	2 2 1	— 1	2 9 1	— —	— —	— —	— —	— —
Past. + 1.3 p.p.m. Cu	— 2	9 ? 2	2 1 1	— 1 1	— 1 —	— 1	? — 1	— —	— —	— —	— —	— —
Cow No. 367 Raw milk	— —	— —	— —	— 2	2 2 1	— ?	4 3 2	4 3 4	3 — 1	— —	— —	— —
Raw milk + 1.3 p.p.m. Cu	— —	— 1 —	— —	— —	— 1 —	— 2	3 2 —	2 3 2	2 — 1	— —	— —	— —
Pasteurized milk	— —	— —	1 1 1	1 7 1	— 1 —	— —	1 7 3	— —	3 — 1	— —	— —	— —
Past. + 1.3 p.p.m. Cu	— 1	— 1 1	— —	— 1	— —	— 1	4 1 —	2 3 2	1 3 1	— —	— —	— —
Cow No. 371 Raw milk	— —	— —	— —	— —	— —	— 1	4 4 4	— —	— —	— —	— —	— —
Raw milk + 1.3 p.p.m. Cu	1 — —	— —	4 4 4	1 1 2	? 1 1	— —	4 1 7	— —	— —	— —	— —	— —
Pasteurized milk	— —	— —	— ? —	1 7 2	— 1 1	— 2	— —	— —	— —	— —	— —	— —
Past. + 1.3 p.p.m. Cu	— —	— —	— —	1 7 2	3 3 2	— —	— —	— —	— —	— —	— —	— —
Cow No. 379 Raw milk	4 4 4	4 4 4	4 4 4	2 2 3	3 3 2	? — 1	— —	— —	— —	— —	— —	— —
Raw milk + 1.3 p.p.m. Cu	2 1 3	1 1 1	2 1 1	3 — 3	2 — 1	3 — 1	— 1 —	1 2 2	— 3 3	— —	— —	— —
Pasteurized milk	— —	1 1 1	1 1 1	— 3	— 1 —	— 3	— —	— —	— 3 2	— —	— —	— —
Past. + 1.3 p.p.m. Cu	— —	— —	— —	— 2	2 2 1	— 2	2 2 1	1 7 2	1 — —	— —	— —	— —
Cow No. 384 Raw milk	— 2	1 1 1	1 1 1	— 3	— 1 —	— 3	— 1 —	3 1 1	— 3 3	— —	— —	— —
Raw milk + 1.3 p.p.m. Cu	— —	— —	— —	— 2	2 2 1	— 2	2 2 1	1 7 2	1 — —	— —	— —	— —
Pasteurized milk	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
Past. + 1.3 p.p.m. Cu	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —

TABLE 3 —Continued

WEEKS	25	26	27	28	29	30	31	32	33	34	35	36
Cow No. 318												
Raw milk												
Raw milk + 1.3 p.p.m. Cu												
Pasteurized milk												
Past. + 1.3 p.p.m. Cu												
Cow No. 364												
Raw milk	— 2 4	4 4 4										
Raw milk + 1.3 p.p.m. Cu												
Pasteurized milk												
Past. + 1.3 p.p.m. Cu	1 3 3	3 4 4										
Cow No. 365												
Raw milk												
Raw milk + 1.3 p.p.m. Cu												
Pasteurized milk												
Past. + 1.3 p.p.m. Cu												
Cow No. 367												
Raw milk					1 —							
Raw milk + 1.3 p.p.m. Cu							— 2					
Pasteurized milk	— 2	— 3 2	4 —	2 1 1	— 3 4	3 4 2	2 3 2	4 3 2	3 4 3			
Past. + 1.3 p.p.m. Cu	— 3	— 2 2	3 —	3 3 2	— 3 3	3 2 3	4 3 4	4 3 3	4 3 4	4 4 2	4 4 4	2 3 3
Cow No. 368												
Raw milk					1 —							
Raw milk + 1.3 p.p.m. Cu						— 2	— 2 3	— ?	1 7 2	3 4 3	4 4 2	4 2 2
Pasteurized milk												
Past. + 1.3 p.p.m. Cu	1 — 3	— 2 2		3 3 2	— 3 3	3 2 3	4 3 4	4 3 3	4 3 4	4 4 2	4 4 4	2 3 3
Cow No. 371												
Raw milk												
Raw milk + 1.3 p.p.m. Cu												
Pasteurized milk												
Past. + 1.3 p.p.m. Cu												
Cow No. 374												
Raw milk												
Raw milk + 1.3 p.p.m. Cu												
Pasteurized milk									— 4 3	? 4 1	2 4 1	2 2 —
Past. + 1.3 p.p.m. Cu	1 2 —	— 3 3	2 —			— 2	— ? ?	— 3 4	— 4 3	? 4 1	2 4 1	2 2 —
Cow No. 379												
Raw milk												
Raw milk + 1.3 p.p.m. Cu												
Pasteurized milk												
Past. — 1.3 p.p.m. Cu												
Cow No. 384												
Raw milk												
Raw milk + 1.3 p.p.m. Cu												
Pasteurized milk						? 2 —			— ? —	— ? 2	3 1 —	— — 2
Past. + 1.3 p.p.m. Cu	— 2 3		2 —			? 2 —		3 —	— 2	— 1 —	2 — 1	? — 3

Meaning of symbols: Boldface type, Cows on dry feed; lightface type, Cows on pasture.

For meaning of other symbols see Table 1, footnote. Study was begun the week of April 4 and finished the week of December 9, 1935.

pasture feeding regimes so that it was possible to make four reversals of feeding in her case.

Collectively considered the data show that subject to considerable individual variation the feeding of fresh pasture grasses to cows results in a reduction or elimination of susceptibility of their milks to oxidized flavor development.

Effects of Tomato Juice, Lemon Juice, and Ascorbic Acid

The experiments described in the foregoing paragraphs indicate quite conclusively that pasture grass contains a substance, or substances, capable of passing from the digestive system of the cow to the milk and lessening the intensity of, or preventing entirely, the subsequent occurrence of oxidized flavor.   In all probability, as Kende (5) has pointed out, such a substance has strong reducing properties.   Probably also it is readily oxidized itself.   The work of Chilson (3) shows that the addition of ascorbic acid (vitamin C) to milk, prevents the development of oxidized flavor.   This was true also for additions of two other reducing substances elone and hydroquinone.   It might be expected therefore that the effect of green feeds on oxidized flavor development is to be explained on the basis of their relatively high vitamin C content.   Accordingly an experiment studying the effects of feeding vitamin C-rich substances and of feeding vitamin C in purified form was planned and conducted.

Three cows known to be producing milk susceptible to oxidized flavor development were selected.   These cows were continued on the dry feeds they were receiving when selected.   This feed was supplemented by 1 quart of a popular brand of canned tomato juice for each cow daily, administered by drenching.   The allowance of tomato juice was doubled after 6 days.   Samples of the milk from each cow were handled so as to avoid contamination with copper in the manner described in connection with the other experiments herein reported.   The results, reported in the forepart of Table 4, show that the feeding of tomato juice caused a notable reduction in the susceptibility of the milks of these cows to oxidized flavor development and that this susceptibility returned within a short time after the feeding of tomato juice was discontinued.

When the milks of the three cows used had become readily susceptible to oxidized flavor development again, one of the cows was given a daily supplement of 0.5 gram of ascorbic acid (Merck's "Cebione") dissolved in slightly less than a quart of distilled water that was slightly acidulated with citric acid.   (This allowance was believed to be approximatley equivalent to the amount of ascorbic acid contained in two quarts of tomato juice, as shown by the work of Bessey and King (1).)   Each of the two other cows was given a daily supplement of one quart of lemon juice, freshly extracted.

The results of this experiment, recorded in the latter part of Table 4, show that the ascorbic acid had a pronounced effect in reducing the susceptibility of the milk to oxidized flavor development. Unfortunately not enough

TABLE 4

The effects of supplementary feeding of tomato juice, lemon juice, and pure vitamin C on the susceptibility of milks to oxidized flavor development

COW	No. 377				No. 378				No 385			
Treatment	Raw		Pasteurized		Raw		Pasteurized		Raw		Pasteurized	
Copper added (p p m)	None	2 6	None	2.6	None	2 6	None	2 6	None	2 6	None	2 6
Date	Dry feeding regime											
4/14/36	–	3	–	2	–	3	–	4	–	3	–	4
4/15/36	–	4	–	4	–	4	–	4	–	2 to 3	–	3
4/16/36	–	3	–	4	–	3	–	4	–	3 " 4	–	3 to 4
4/17/36	–	3	–	3	–	4	–	4	–	2 " 3	–	3
	Dry feed supplemented by 1 quart of tomato juice daily											
4/18/36	–	1 to 2	–	1 to 2	–	2	–	2	–	1	–	1 to 2
4/19/36	–	1	–	?	–	2 to 3	–	2 to 3	–	2 to 3	–	1 " 2
4/20/36	–	?	–	1	–	1 " 2	–	2 " 3	–	1	–	2
4/21/36	–	?	–	1	–	–	–	1	–	1	–	1
4/22/36	–	?	–	?	–	?	–	1	–	1	–	1
4/23/36	–	1	–	?	–	?	–	1	–	1	–	1
	Dry feed supplemented by 2 quarts of tomato juice daily											
4/24/36	–	?	–	1	–	–	–	–	–	–	–	–
4/25/36	–	?	–	–	–	–	–	?	–	1	–	?
4/26/36	–	–	–	–	–	–	–	–	–	?	–	?
4/27/36	–	1	–	?	–	–	–	–	–	–	–	–
4/28/36	–	?	–	?	–	–	–	–	–	–	–	–
4/29/36	–	?	–	?	–	–	–	–	–	–	–	–
4/30/36	–	?	–	?	–	?	–	?	–	–	–	?
	Dry feed without supplement 5/1/36											
5/ 2/36	–	?	–	?	–	–	–	–	–	?	–	1
5/ 3/36	–	1	–	?	–	–	–	–	–	1	–	?
5/ 4/36	–	–	–	–	–	1	–	1	–	1	–	?
5/ 5/36	–	1	–	1	–	–	–	1	–	1	–	1
5/ 6/36	–	2	–	1	–	?	–	2	–	?	–	?
5/ 7/36	–	2	–	2	–	1	–	2	–	2	–	2
5/ 8/36	–	3	–	3	–	1 to 2	–	2 to 3	–	1	–	3
5/ 9/36+	–	1	–	1 to 2	–	2	–	2 " 3	–	1	–	1
5/10/36	–	2 to 3	–	1	–	2	–	3	–	?	–	1
5/11/36	–	2	–	2	–	1 to 2	–	2	–	1	–	2
5/12/36	–	1	–	1	–	1	–	1 to 2	–	1	–	1
5/13/36	–	2	–	1 to 2	lost	lost	–	2	–	1	–	2
5/14/36	–	2	–	2	–*	–*	–	1 to 2	–	2	–	1
5/15/36	–	2	–	2	–*	–*	–	2	–	2	–	2
5/16/36	–	3	–	2	–*	–*	–	1 to 2	–	2 to 3	–	3 to 4
5/17/36	–	3	–	3	–*	–*	–	2	–	4	–	4
5/18/36	–	4	–	4	–*	–*	–	2	–	3	–	3
5/19/36	–	4	–	4	–**	–**	–	2	–	3	–	3
5/20/36	–	4	–	3			–	2	–	4	–	3
5/21/36	–	4	–	4			–	2	–	3	–	3
5/22/36	–	4	–	3 to 4			–	3	–	3	–	3

TABLE 4.—*Continued*

COW	No. 377				No 378				No 385			
Treatment	Raw		Pasteurized		Raw		Pasteurized		Raw		Pasteurized	
Copper added (p p m.)	None	2.6	None	2 6	None	2.6	None	2 6	None	2 6	None	2 6
	Dry feed supplemented by 0.5 gram Merck's Cebione (Vitamin C) daily				Dry feed supplemented by 1 quart lemon juice daily				Dry feed supplemented by 1 quart lemon juice daily			
5/23/36	–	4	–	3			–	3	–	4	–	3
5/24/36	–	4	–	3			–	3	–	3 to 4	–	3
5/25/36	–	1	–	–			–	1 to 2	–	2	–	1
5/26/36	–	2	–	?			–	3	–	2	–	1
5/27/36	–	2	–	1			–	2	–	2	–	1
5/28/36	–	2	–	1			–	1	–	2	–	1
5/29/36	–	?	–	?			–	–	–	1 to 2	–	?
5/30/36	–	1	–	?			–	–	–	–	–	–
	Feeding of Vitamin C discontinued 5/30/36				Feeding of lemon juice discontinued 5/31/36				Feeding of lemon juice discontinued 5/31/36			
5/31/36	–	1 to 2	–	?			–	–	–	–	–	?
6/ 1/36	–	2	–	1	–	–			–	–	–	3
6/ 2/36	–	2 to 3	–	1 to 2	–	?			–	3	–	3
6/ 3/36	–	3	–	2	–	1			–	2 to 3	–	3
6/ 4/36	–	4	–	3			–	2 to 3	–	3	–	3
6/ 5/36	–	4	–	4			–	2	–	3	–	4
6/ 6/36	–	3	–	4			–	3	–	4	–	4
6/ 7/36	–	3	–	4			–	4	–	4	–	4
6/ 8/36	–	3	–	4			–	3	–	5	–	4

Meaning of symbols: +, cows received 2 hours' pasture; *, slight rancid; **, rancid. For meaning of other symbols see Table 1, footnote.

ascorbic acid was on hand to continue the feeding of it until susceptibility was completely eliminated. However, the marked reduction in susceptibility, followed by its rise after the feeding of ascorbic acid was discontinued, is good evidence that vitamin C passes to the milk and tends to make it non-susceptible to oxidized flavor development. A parallel effect of the feeding of lemon juice, also shown in Table 4, is further evidence that vitamin C in the feed of the cow affects her milk, reducing its susceptibility to oxidized flavor development.

SUMMARY AND CONCLUSION

A study of the susceptibility of both individual and mixed milks to oxidized flavor development throughout a period of a year showed the following results:

(1) There is considerable variation among individual cows with respect to the tendency for oxidized flavor to develop in their milks.

(2) Dry feeding increased the tendency for oxidized flavor to develop in milk, and grazing on fresh pasture decreased this tendency.

(3) The feeding of one quart per animal daily of either tomato or lemon juice to cows on dry feed greatly reduced the susceptibility of the milks to oxidized flavor development.

(4) Pure crystalline ascorbic acid fed at the rate of one-half gram daily, likewise greatly decreased the tendency for oxidized flavor to develop.

Since fresh green vegetation, tomato juice, and lemon juice all are known to contain considerable amounts of vitamin C, and since the feeding of small amounts of pure ascorbic acid produced a similar effect, it seems reasonable to conclude that vitamin C in the rations of dairy cows may reduce or entirely eliminate the susceptibility of their milks to oxidized flavor development.

ACKNOWLEDGMENT

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THE USE OF FORMATE–RICINOLEATE BROTH IN CONTROLLING AND PREVENTING ROPY MILK EPIDEMICS

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Despite the excellent information available for controlling ropy milk, this defect continues to be a problem to the dairy industry. Ropy milk is closely associated with sanitation and proper plant methods and when the latter become lax, ropy milk and other defects are apt to develop.

Investigations of the past have shown that ropy milk bacteria are widely distributed where milk is produced and handled. They have been found in feeds, barn dirt, water holes, raw milk, utensils, milk plants, etc. (1, 2). Realizing the above facts, it is plain to see that most, if not all milk plants receive a certain number of ropy milk bacteria in the raw milk supply and the organisms are often prevalent in the plant itself. The problem then is to recognize the universal distribution of these organisms on the farm and in the plant and to adopt effective methods for their control.

The best authorities on dairy bacteriology are confident and convinced that ropy milk can be controlled in the plant by proper sanitation and efficient pasteurization with no recontamination after pasteurization. Rogers, Sherman, and Hastings (3) state as follows: "Whenever the bottled milk is affected, it is well to assume that contamination has occurred after pasteurization, and take every precaution to eliminate the bacteria throughout the plant." Recontamination after pasteurization is perhaps more common than is realized, as may be seen by the figures quoted by Stark (4) : "Results obtained in this laboratory and also much more extensive data (Tiedeman, *et al*, 1935), made available through the kindness of Mr. W. D. Tiedeman, have shown between 11 per cent and 40 per cent of the pasteurized milk which showed no colon organisms at the end of the holding period to contain these organisms when the milk comes from the bottler."

One method commonly employed in controlling ropy milk outbreaks is to set producers' samples at 60–65° F. and test them at intervals for ropiness. There will always be a small percentage of the samples which will become ropy, even when there is no ropy milk in the pasteurized product. Ropy bacteria often predominate in raw milk of high quality and such milk will often rope before it sours. The ropy sample may have developed from very few ropy bacteria but such samples are always possible sources of future trouble. When one is confronted with a serious ropy milk outbreak, and it is necessary to test all possible sources, producers' samples may be set at 60–65° F. and tested at various intervals for rope, to determine the extent of

contamination. However, to prevent or correct ropy milk epidemics our experience, as well as that of others (3, 5, 6), has indicated that tests made on the product at various stages as it passes through the plant operations will detect the major cause of the trouble. The plant operator will know long before the consumer if the product becomes ropy and can take steps for its correction. As very few, if any, of the process samples would become ropy, they would not be a source of contamination for the plant.

Ropy milk has been shown to be due to a number of different organisms. Hammer (7) ascribes many ropy milk outbreaks in the United States to *Bacterium lactis viscosum* and organisms of the Escherichia-Aerobacter group. Stark and Foter (1) isolated five hundred ropy milk cultures from various sources and divided them into seven distinct groups. Two of the groups which comprised the majority of the cultures isolated, were Gram-negative, gas producing rods, which they believed to be members of the Escherichia-Aerobacter group of organisms. Most of the ropy milk outbreaks in New York State, at least, are caused by organisms of the Escherichia-Aerobacter group.

It is believed that a selective medium such as formate-ricinoleate broth (8) which permits organisms of the Escherichia-Aerobacter group to grow rapidly and produce gas and inhibits the so-called false test organisms, is of great value in controlling and preventing ropy milk outbreaks as well as other defects in milk products. Stark and Curtis (9) testing various culture media for water and milk analysis found that formate-ricinoleate broth was best suited for the detecting of colon organisms in milk.

TABLE I

The value of formate-ricinoleate broth as a detector of ropy milk bacteria in the product during various stages of processing

PLANT PROCESS SAMPLES	GAS IN FORMATE-RICINOLEATE BROTH AFTER 20 HOURS AT 98 °F.	ROPE IN ORIGINAL SAMPLE AFTER 20 HOURS AT 60–65 °F.
Pasteurized heavy cream from can	+	+
Pasteurized heavy cream from bottler	+	+
Bottle of pasteurized heavy cream	+	–
Pasteurized light cream from can	+	–
Pasteurized light cream from bottler	+	–
Bottle of pasteurized light cream	+	–
Milk from vat No. 1, preheated to 144° F.	–	–
Milk from vat No. 1 after being held 30 minutes at 144° F.	–	–
Sample of milk taken from pipe leading to the bottler. (Cream did not go through this pipe, but was dumped directly into the bottler)	–	–
Sample of milk taken from the bottler	+	+
First bottle of milk	+	+

This medium has been used successfully in one plant for eliminating ropy milk, together with correcting faulty plant practices and sanitation. Plant process samples may be taken one morning and in most cases interpreted the next day before plant operations begin. The presence of Escherichia-Aerobacter organisms in pasteurized milk or cream is an indication of recontamination resulting from faulty plant sanitation and methods. After the samples have been examined and the point of recontamination has been located, steps may be taken immediately to correct the fault.

Table I shows the results of process samples taken in one plant during a ropy milk epidemic showing that the cream (which was bottled first), was the source of the ropy organisms in the milk. The pasteurized milk was free of ropy milk bacteria until it came in contact with the bottler, where it was contaminated by the cream remaining in the filler. It will be noted that samples which showed gas in formate-ricinoleate broth developed rope when held 20 hours at 60–65° F.

Table II shows the results of the samples taken the second day when the cream was bottled last.

TABLE II

Other tests showing the value of formate-ricinoleate broth

PLANT PROCESS SAMPLES	GAS IN FORMATE-RICINOLEATE BROTH AFTER 20 HOURS AT 98 °F.	ROPE IN ORIGINAL SAMPLE AFTER 20 HOURS AT 60 65 °F
Milk from vat No. 1, preheated to 144° F.	–	–
Milk from vat No. 1, after being held 30 minutes at 144° F.	–	–
Sample of milk taken from pipe leading to the bottler	–	–
Sample of milk taken from the bottler	–	–
Pasteurized heavy cream from can	+	+
Pasteurized heavy cream from bottler	+	+
Bottle of pasteurized heavy cream	+	+
Pasteurized light cream from can	+	‚
Pasteurized light cream from bottler	‚	‚
Bottle of pasteurized light cream	+	+

This does not imply that when a sample of pasteurized milk or cream contains Escherichia-Aerobacter organisms as demonstrated by the presence of gas in formate-ricinoleate broth, that it will necessarily develop rope when placed at 60–65° F., but it is a potential ropy and gassy product. However, a pasteurized product free from Escherichia-Aerobacter organisms is safe from the standpoint of rope in most, if not all cases.

Formate-ricinoleate broth may be further used during ropy milk outbreaks to detect unsanitary conditions and faulty plant methods. Samples may be inoculated into formate-ricinoleate broth and in most cases the results

may be read before operations begin the next morning. This test is rather delicate and will detect any defect in sterilization of equipment or recontamination after pasteurization. It was several days in the aforementioned ropy outbreak before pasteurized heavy and light cream could be obtained which was free from Escherichia-Aerobacter organisms. Contamination was traced to the cooler, dipper and the cans.

SUMMARY

Ropy milk bacteria are present practically everywhere milk is handled. They can be controlled in the plant by proper sanitation and plant methods. Checking plant process samples routinely for ropiness and other defects is more effective than checking producers' samples.

Most ropy milk outbreaks in New York State are caused by members of the Escherichia-Aerobacter group of bacteria. The value of formate-ricinoleate broth in detecting ropy milk bacteria and faulty plant sanitation and methods is pointed out. Plant process samples showing gas in formate-ricinoleate broth may or may not develop rope, but samples showing no gas will not develop rope in most, if not all cases when samples are placed at 60–65° F.

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PERSISTENCY OF PRODUCTION IN JERSEY COWS AND ITS PRACTICAL APPLICATION

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Aside from external factors, the production record completed by any cow depends on initial maximum yield plus persistency of production during the lactation. Persistency of production is difficult to define but may be expressed or measured as the rate of decline in milk and fat yield from the maximum production after parturition until milk secretion ceases. For years breeders have recognized that some cows hold up in their milk flow remarkably well for a long time while others tend to dry off sooner than they should. Various methods and means of measuring persistency have been suggested and investigators have attempted to evolve a satisfactory method of expressing persistency of production by a single numerical figure. It is not the attempt of this paper to review the published work that has been done but instead to present some observations on persistency of production as observed in Jersey cows and to attempt to show the practical significance of persistency.

The official Register of Merit, Advanced Registry and Herd Test records as now published in annual volumes by the Breed Associations giving only the total milk and butterfat yields do not furnish as much information as may be desired regarding persistency. However, the month by month records on file in the Breed Association offices do provide inviting material for the study of persistency of milk and butterfat production.

There are just twenty Jersey cows that have completed yearly Class A records of over one thousand pounds of butterfat. These were selected for analysis. The cows with Class AA records were excluded to eliminate any influence due to advanced pregnancy. The twenty records were then divided into twelve thirty day periods discarding the last five days of each lactation. The exact milk and butterfat yields, were calculated for each thirty day period. From these yields the percentage of the total 360 day production produced in each thirty day period was determined. These percentages were then charted. Figure 1, shows a composite graph of the lactation curves for these records as thus determined.

It will be noted that the composite curves show a gain in production for the second thirty day period, then a gradual and almost regular decline for the remainder of the year. This seems to bear out Turner's (1) statement that when all other conditions are uniform, the monthly milk or fat yield during the lactation period, after the maximum is past, is a constant percentage of the preceding month's production. These percentages for milk yield were found to be 95.6, 93.8, 95.4, 96.5, 96.5, 96.4, 98.8, 97.6, 97.2 and
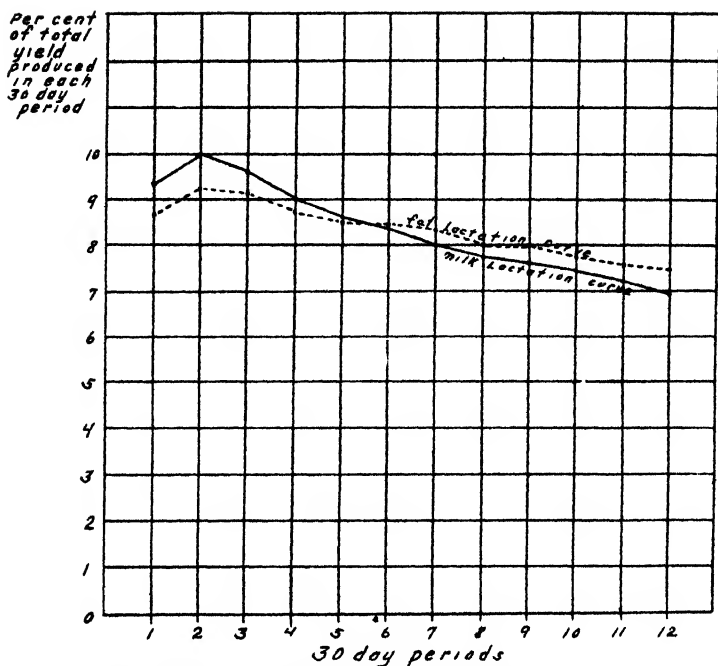
Figure 1. Composite lactation curves for all 1000 lbs fat, Class A records

96.1.   Several of the individual records, however, do show considerable variation in the lactation curve.

For a direct comparison, thirty yearly Class A records which failed to meet the minimum Register of Merit requirements were selected at random. Lactation curves for these low records were similarly determined and are shown in figure 2.

These curves show pronounced variation from the curves in the first figure and the two graphs illustrate extremes in persistency of lactation. The average monthly milk yield of each month was compared with the preceding month's milk production and the percentages were found to be 93.6, 90 4, 92.4, 90.8, 92.6, 93.3, 89.5, 92.0, 89.3 and 83.2.   Since these were all Class A records indicating that any pregnancy during the lactation was of less than 155 days in length, it is hardly possible that pregnancy could have caused the greater decline during the last month.   Perhaps management and feeding were mainly responsible.

For a third comparison, thirty, 305 day Class A records also failing to meet the Register of Merit requirements were selected at random.   The production for each thirty day period was calculated and the last five days discarded.   The percentage of the total yield produced in each thirty day
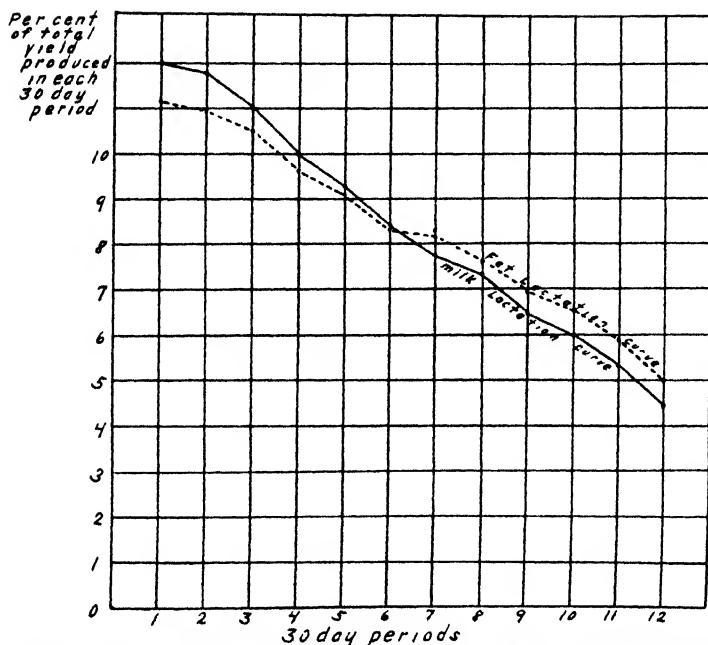
Figure 2 : Composite lactation curves for 30, yearly, "failed to qualify", Class A, records

period was then determined and these percentages plotted. The results are given in figure 3.

In these records the average rate of decline in milk and butterfat yield was found to be even more pronounced. Comparing each month's yield with the preceding month's yield, after the second month the percentages were found to be 90.6, 90.1, 90.1, 88.0, 88.8, 90.0, 85.7 and 77.8. Here again the rate of decline was remarkably constant up until the eighth month and then the decline became considerably more pronounced. In all three groups these percentages show slightly more uniformity based on butterfat yields than on milk yields and it would appear that Turner's statement applies even more closely to fat or to total energy yield than to milk yield alone. In both of these low record groups a great variation in persistency was observed. Comparing the 360 and 300 day productions with the maximum month yield, it was found that there existed a considerable range in total yield with cows producing about the same amount during their maximum month.

In the 360 day group, the maximum thirty day yield was 58.86 pounds of fat with a total yield of 336.73 pounds of fat. The cow with the lowest maximum thirty day yield had a thirty day production of 35.48 pounds of fat and a total yield of 352.94 pounds of fat. In the 300 day group, the highest maximum thirty day yield was 54.74 pounds of fat with a total yield
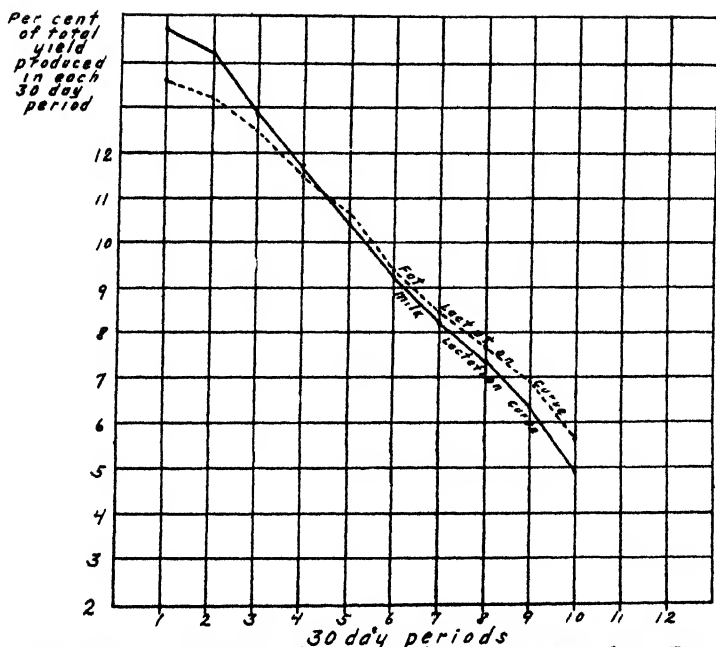
Figure 3   Composite lactation curves for 30
"failed to quality", 305 day, Class A, records

of 329.78 pounds, while the low maximum thirty day yield was 28.58 pounds
with a total production of 224.09 pounds.

It was also observed that with the thousand pound producers sixteen
cows produced more milk during their second thirty day period than during
the first thirty day period. With the low yearly record cows, only eleven
out of thirty produced more milk during the second thirty day period than
during the first thirty day period and with the 300 day low record cows, in
twenty-two cases, the most milk was produced in the first thirty day period.

The lactation curves for fat and milk were also plotted individually for
each record and it was noticed that the rate of decline was less in a few cases
with the low record cows than with the thousand pound fat producers, again
demonstrating that total yield alone is not an infallible indication or mea-
sure of persistency.

Figure 4 shows the fat percentages for each of these three groups. While
the high record cows were invariably higher testers, the rate of increase in
fat test during the lactations was fairly similar for all three groups. Fat
percentage did show a slightly greater increase in the 300 day low record
cows than in the other groups and it seems possibly the reason for this was
that the production of these cows was extremely low during the ninth and
tenth months of their records. In fact, the average milk yield for the tenth

month of this group was 282 pounds of milk, whereas the average tenth month milk yield for the yearly low record group was 409 pounds and the average twelfth month milk yield for this group was 300 pounds.
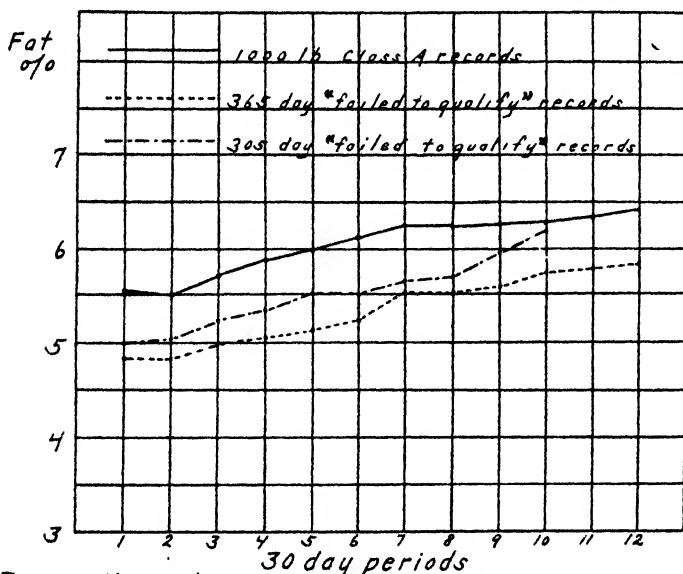
Figure 4: Fat percentage curves for 1000 lbs Class A, records, for 365 day and for 305 day low records

The foregoing data and most of the work published on persistency of production have been done with Register of Merit or Advanced Registry records. All records used were either 305 or 365 days in length for in the past the records of cows that went dry earlier and which did not meet the production requirements were not published. It seems obvious that a cow must possess a considerable degree of persistency to continue to milk for ten or twelve consecutive months following normal parturition. In the Herd Improvement Registry of the American Jersey Cattle Club, the individual records are all published on the basis of lactation periods. A lactation period includes the production beginning with the fourth day after calving until the cow is dry. The dry date is considered as the day on which a cow is last milked daily. These complete Herd Test lactation records to December 31, 1935 have now all been averaged and the averages are given in Table 1.

In examining this Table, it will be noted that of 6167 complete lactation records completed by cows of all ages, there were 576 records or 9.34 per cent which were 240 days or less in length, while 1225 records or nearly twenty per cent were 270 days or less in length. All the records of 240 days or less in length which were either first calf records or preceded by a dry

TABLE 1

Average yields of herd test lactations for all ages

LENGTH OF LACTATIONS	NUMBER	PER CENT OF TOTAL	AV. MILK YIELD	AV. PER CENT	AV. FAT YIELD
180 days or less	219	3.55	2166	5.070	109.85
181 to 210 days	120	1.95	3682	5.307	195.41
211 to 240 days	237	3.84	4357	5.165	225.06
241 to 270 days	649	10.52	5434	5.247	285.10
271 to 305 days	1471	23.85	6310	5.300	334.41
306 to 335 days	1368	22.18	7329	5.316	389.58
336 to 365 days	2063	33.45	8116	5.411	439.15
Totals	6167	100.00	6778	5.338	361.79

period of at least three weeks and which in all cases were followed by a dry period of at least three weeks and then followed by another complete lactation were sorted out. There were 144 such cases. The short lactations of less than 240 days were then compared with the next succeeding lactations both in length and in total production. Table 2 gives a tabulation of the results of this comparison.

TABLE 2

Length and yields of short lactations compared with lengths and yields of succeeding lactations

LENGTH GROUPS	SHORT LACTATIONS	NEXT SUCCEEDING LACTATIONS	PRODUCTION GROUPS	SHORT LACTATIONS	NEXT SUCCEEDING LACTATIONS
0 to 30 days	1	0	0 to 50 lbs.	5	2
31 to 60 days	1	0	51 to 100 lbs.	10	8
61 to 90 days	3	1	101 to 150 lbs.	25	14
91 to 120 days	6	6	151 to 200 lbs.	37	15
121 to 150 days	11	12	201 to 250 lbs.	31	28
151 to 180 days	14	10	251 to 300 lbs.	25	32
181 to 210 days	30	17	301 to 350 lbs.	6	15
211 to 240 days	78	17	351 to 400 lbs.	1	15
241 to 270 days	0	24	401 to 450 lbs.	1	7
271 to 305 days	0	27	451 to 500 lbs.	0	5
306 to 335 days	0	16	Over 500 lbs.	0	3
336 to 365 days	0	14			
Totals	144	144	Totals	144	144

The average length of these 144 short lactations was 198 days and the average butterfat production was 196 pounds. The average length of the next succeeding lactations of these 144 cows was 244 days and the average production was 264 pounds of butterfat. Of these 144 short lactations there were thirty which followed first calvings. These records averaged 186 days

in length and the average production for the thirty lactations was 157 pounds of butterfat. The second lactations completed by these thirty heifers averaged 243 days in length and 258 pounds of butterfat. Nineteen of the thirty heifers also had a third complete lactation and these nineteen third complete lactations averaged 255 days in length with an average production of 254 pounds of fat. In examining the second lactations completed by this group of thirty heifers, it was noticed that in only seven instances did the lactations exceed 300 days in length while there were sixteen second lactations which were less than 240 days in length. Gaines and Davidson (2) state that younger cows are more persistent milkers than older cows and Turner (3) concludes that there is a decline in persistency during the lactation period as the dairy cow reaches maturity.

Of course, nothing is known as to how these cows were handled or fed but Turner (4) has shown that overfeeding will not increase the maximum persistency of secretion which a cow inherits. It is obvious that environment, nutrition, pregnancy and season of the year of freshening are all important factors in affecting persistency and yet the evidence is that persistency is an inherited character and that some cows have an ability to hold up in production much longer than other cows handled under similar conditions. These Herd Test records were in most cases made on twice a day milking while all of the one-thousand pound records and the majority of the low Register of Merit records studied were made with three milkings per day. Frequency of milking may also be a factor which may influence persistency but the results on the Register of Merit records would indicate that such influence was not large.

SUMMARY

The significance of these results to practical breeding may be summarized as follows:

1. Total production for a lactation period seems to give some indication regarding persistency for the high producing cows were in the great majority of cases much more persistent than were the extremely low producers.

2. Maximum yield of milk or butterfat after calving does not give much information regarding persistency. Cows with the same initial rate of yield after parturition may vary greatly in persistency of production.

3. Cows with a low total production seem to reach their maximum rate of yield earlier in the lactation than do cows with a high total production.

4. Persistency seems to be an inherited character, persisting throughout a cow's lifetime. If a first calf heifer shows, under normal conditions, an inability to milk for at least eight or nine months, the chances appear against her developing into a profitable cow during later lactations.

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SOME FACTORS INFLUENCING FAT CONTENT IN ICE CREAM MIX AND THE CORRESPONDING FINISHED ICE CREAM AS DETERMINED BY THE MOJONNIER METHOD

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For a number of years there has been a belief among ice cream manufacturers that ice cream always tests lower in fat than the mix from which it was made. The difference ranges from 0.05% to as high as 0.50% with an average of about 0.20%. While seemingly small this difference has a commercial significance. Two-tenths per cent difference in butter fat based on the total weight of ice cream is equivalent to 1.75% of the total fat for a 12% ice cream. When standardizing mix to a definite percentage of butter fat, especially when it is a legal limit, the operator knows from experience that he must add extra cream and it is this "extra can of cream" that must be explained. Usually the chemist is called upon for the explanation and this had led to the development of new methods of analysis, no two of which seem to agree. There are those who claim there is no difference in the butter fat content of ice cream mix and the finished ice cream, and others who claim there is a definite loss of fat in the finished product.

L. K. Crowe (1) states that ice cream must be melted below 27% C. to prevent melting of the fat and that the fat must not be churned.

Bird and Johnson (2) compared the fat content of ten mixes and the finished ice cream made from these mixes. The average fat content of the mix was 13.44% while the frozen ice cream averaged 13.29%. In this same bulletin the investigators point out that "It is possible to induce variations as great as 1 per cent in the fat analysis of ice cream that has been melted and has been agitated to mix it."

Vasily Kniaseff in his modified Babcock method to determine fat in ice cream (3) calls attention to the fact that when the ice cream samples were not in good condition there was a discrepancy in the results and in order to use his method successfully great care must be exercised in selecting and handling the samples.

EXPERIMENTAL

In one of our plants the operators had been having trouble in getting checks between ice cream samples and the mix from which this ice cream was made. In fact they had difficulty in securing checks on samples of the same ice cream taken from different parts of the package, some of the samples varying as much as 2 per cent. It was thought that the freezing operation caused a shrinkage in the fat content. In their procedure for analysis they had always shaken the samples vigorously when melting them.

In order to check on this, an experiment was outlined and carried out as follows: Samples of mix of different fat contents were taken from last point possible before it entered the freezer, in this case the freezer hoppers. This was done so that there would be no calculation necessary for any dilutions, such as addition of flavor or color, made at the freezer. In other words the sample was taken when all additions were made and the analysis should be exactly the same as the frozen ice cream. The ice cream for sampling was taken immediately on freezing from the freezer, placed in a regular pint package and hardened as usual in the hardening room. When hardened it was sampled in the following manner: The frozen packaged ice cream (1 pint) was cut into quarters and one of these was placed in a clean, dry half-pint milk bottle and the top covered by a disc cap and an open hood cap. The bottle was placed in a tank of water which was at a temperature of 25° C.–32° C. and allowed to stand until a clear layer formed beneath the layer of foam. Then instead of a vigorous shaking as was the general practice, the bottle was rotated carefully so that the mixture did not splash high against the sides of the bottle, but so the clear bottom layer and the top foam were thoroughly mixed. The bottle then was set in the bath and the layers allowed to separate. This procedure was repeated until two or three consecutive shakings did not result in a decrease in size of the layer of foam.   •

The sample for testing was then taken by dipping the end of a pipette into the clear bottom layer and drawing in the required amount. The analysis then followed the regulation Mojonnier procedure.

The results checked closely, the greatest difference being 0.09% between mix and ice cream made from the mix. It seems logical to assume that perhaps the difficulty in securing checks between ice cream and mix lay in the fact that the sample was shaken too vigorously. Table I shows the results of the analyses obtained by use of the above procedure:

TABLE I

Relation of butter fat content of ice cream mix and of ice cream when sampling was carefully done

SAMPLE	B. FAT IN ICE CREAM	B. FAT IN MIX
1 vanilla	10.01	10.04
2 vanilla	12.19	12.10
3 vanilla	16.00	15.94
4 chocolate	12.04	11.98

The above table indicates that a gentle treatment of the sample is necessary. It is generally known that the fat content of foam is high. Since much of the fat is in the foam it must be worked into solution by the repeated gentle rotations. Vigorous agitation throws fat high on the sides of

the bottle where it adheres and does not enter again the melted mixture from which the sample to be analyzed is drawn.

In order to obtain more complete information on the subject an experiment of greater scope was planned and carried out in another manufacturing plant. The standard Mojonnier apparatus and method for fat determination was used and results checked in the Research Laboratories. The ice cream mix was sampled with a small long-handled dipper and then poured into 8 ounce rubber stoppered Mojonnier sample bottles, care being taken not to wet the neck. The frozen ice cream was sampled from the cans in the hardening room by means of a 1 inch wood bit after first scraping off about $\frac{1}{2}$ inch of ice cream from the top.

The samples were then allowed to warm to room temperature or were placed in warm water (29° C.) until melted after which they were allowed to stand until approximate room temperature had been reached.

The samples were mixed by gently rotating the bottle and washing down any moisture on the side walls after which the rubber stopper was loosened just enough to release the pressure. Five gram samples were immediately taken in lots of four by means of the Mojonnier 5 cc. pipettes which were inserted to approximately one-third the depth of the liquid. When one set of samples was extracted the next set was weighed and so on until three sets had been completed.

The Effect of Vigorous Shaking of Melted Ice Cream Samples

Shaking the melted ice cream samples causes a separation of fat and solids which cling to the walls of the bottle or float on the surface of the liquid and since the test sample is taken below the surface the fat content is invariably lower as shown in Table II.

Preliminary tests on the ice cream mix were made to determine any difference in composition due to standing, and to insure complete mixing. Results in Table III show that a fat separation takes place.

Agitation of the mix causes the formation of a heavy layer of foam approximately 3 inches thick. At a later date this foam from a batch of mix of lower fat content (12.46%) was sampled and analyzed as follows:

The concentration of butterfat in the foam which on standing again liquefies, probably accounts for the higher fat content of the sample of mix from the top of the batch as shown in Table IV. Since the analysis showed complete uniformity after 30 minutes gentle mixing in the holding vat, this procedure was used throughout the rest of the tests.

Observations were made in the plant to determine the usual plant practice, type of apparatus and any other factors which might have any bearing on the analytical results. All factors which were considered of importance as to the effect on the composition of the ice cream mix or frozen cream were listed as follows:

TABLE II

Influence of vigorous agitation of samples upon accuracy of butter fat tests

SAMPLE NO.	WELL SHAKEN % FAT	GENTLY MIXED % FAT
1	13.43	13.65
2	13.31	13.72
3	13.17	13.72
4	13.27	13.69
5	13.44	13.67
6	13.37	13.67
7	13.05	13.69
8	13.33	13.74
9	13.19	13.71
10	13.28	13.73
11	13.00	13.71
12	13.11	13.71
Average	13.25	13.70

Ice cream melted at room temperature (29° C.) in a closed Mason jar then placed in tightly stoppered Mojonnier sample bottles.

TABLE III

Distribution of butter fat in ice cream mix after 24 hours holding at 20° C.

SAMPLE	% FAT				AVERAGE
Top of mix in vat	13.78	13.89	13.77	13.68	13.78
Bottom of mix in vat	12.94	12.95	12.91	13.00	12.95
					13.365
	(after stirring 30 minutes)				
Top of mix in vat	13.68	13.68	13.70	13.64	13.67
Bottom of mix in vat	13.68	13.69	13.65	13.71	13.68
					13.675

TABLE IV

The butter fat and total solids in the foam on the ice cream mix

	ANALYSIS OF FOAM		ANALYSIS OF MIX
	Research Laboratories analysis	Plant Laboratory analysis	
	per cent	*per cent*	*per cent*
Fat	13.10	13.06	12.46
Total Solids	39.71	39.64	38.49

1. *Mixing.*

The ice cream mix was sometimes drawn off from the holding vat before starting the agitator or running sufficient time.

2. *Added Flavor and Color.*

Flavor and color is added at the freezer. The amount was sufficient to cause a fat reduction of 0.14% in the batches of vanilla ice cream made in this plant.

3. *Temperature and Humidity.*

More or less condensation of moisture was noted on the exposed inner walls of the holding vats as well as on the outer surfaces, depending upon the temperature and humidity. This condensation was very noticeable in the Monel metal hopper refrigerated by brine at an approximate temperature of 5° to 10° F. and into which the ice cream is run from the freezers. This hopper is funnel-shaped, 7 feet long, 7 inches wide, and 7½ feet deep.

4. *Freezing and Whipping Time.*

During the total freezing time an indefinite volume of air passes through the freezer, thereby the moisture present in the air is condensed out by the ice cream. The amount of moisture taken up depends upon the amount of this air and its relative humidity.

5. *Rinsing.*

It is customary to rinse out the freezers and hopper when changing flavors. Considerable moisture may be picked up by the first freezing after this rinsing.

Four different batches of mix and the ice cream from these mixes were sampled and analyzed, twelve separate samples being taken from each batch of ice cream mix and the finished ice cream. On batch No. 1 the results by the standard Mojonnier method of analysis were checked in the Research

TABLE V

The butter fat percentage of the ice cream mix and the finished ice cream

	BATCH NO 1			BATCH NO. 2		BATCH NO 3		BATCH NO. 4	
	Mix Standard Mojonnier Method	Mix Modified Mojonnier Method	Ice Cream	Mix	Ice Cream	Mix	Ice Cream	Mix	Ice Cream
1	13.87	13.90	13.65	13.91	13.65	13.85	13.54	14.09	13.80
2	13.87	13.91	13.65	13.89	13.72	13.83	13.60	14.07	13.79
3	13.84	13.85	13.68	13.86	13.72	13.84	13.57	14.08	13.79
4	13.91	13.92	13.65	13.92	13.73	13.84	13.52	14.11	13.79
5	13.99	13.91	13.67	13.88	13.69	13.85		14.09	13.80
6	13.92	13.90	13.61	13.89	13.67	13.86	13.56	14.11	13.77
7	13.89	13.90	13.62	13.89	13.67	13.88	13.54	14.10	13.80
8	13.94	13.90	13.68	13.91	13.69	13.87	13.58	14.07	13.80
9	13.90	13.91	13.60	13.88	13.74	13.87	13.53	14.09	13.78
10	13.94	13.90	13.64	13.91	13.71	13.88	13.57	14.09	13.80
11	13.91	13.91	13.60	13.89	13.71	13.83	13.59	14.11	13.79
12	13.90	13.86	13.64	13.91		13.82	13.55	14.06	13.81
Average	13.90	13.90	13.64	13.89	13.70	13.86	13.56	14.09	13.79
Corrected*	13.76	13.76		13.75		13.72		13.95	

* 18 oz. vanilla and color added to each freezer equivalent to a fat reduction of 0.14%.

Laboratories by a slightly modified Mojonnier method in which the only difference was in drying the butter fat in an electric oven for 30 minutes.

The butter fat content of the ice cream mix is corrected for added flavor for comparison with the finished ice cream. The analysis as shown in Table V and the summary of these analyses in Table VI shows the difference in fat content between the ice cream mix and the ice cream due to the absorption of moisture during manufacture.

TABLE VI

Summary of Table V showing relation of fat difference to temperature and humidity

ICE CREAM	FAT IN MIX	FAT IN ICE CREAM	DIFFERENCE	TEMPERA-TURE	HUMIDITY	VISIBLE CONDENSATION IN HOLDING VAT AND HOPPER
	Per cent	*Per cent*	*Per cent*	° *F.*	*Per cent*	
1	13.76	13.64	0.12	64	38	slight
2	13.75	13.70	0.05	45	36	none
3	13.72	13.56	0.16	84	42	wet
4	13.95	13.79	0.16	81	65	wet

For 50 quarts ice cream mix per freezer (115.6 lbs.).

0.12% fat reduction is equivalent to addition of 1.00 lbs. added water.

0.05% fat reduction is equivalent to addition of 0.42 lbs. added water.

0.16% fat reduction is equivalent to addition of 1.37 lbs. added water.

SUMMARY

The largest contributing factor to variation in the fat content of ice cream mix and the finished ice cream is improper handling of the ice cream samples whereby a fat and solid separation takes place during melting making it impossible to get a representative sample for analysis.

Violent or continued agitation of the ice cream mix results in a concentration of fat and solids in the top layer of the mix and a reduction in the lower layer. The accumulated foam layer should be stirred into the ice cream mix and the agitation stopped just before drawing the mix to the freezers.

Condensation of moisture in the standardized ice cream mix and in the ice cream during freezing causes a fat reduction especially when the relative humidity is high, and when the frozen ice cream is delivered from the freezers to metal hoppers.

The adding of color and flavor at the freezers causes a definite fat reduction which may be calculated.

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STREPTOCOCCUS DURANS N. SP.

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In a previous paper (1) we described, under the cumbersome name of *Streptococcus hemothermophilus,* an actively hemolytic streptococcus obtained from milk powder. This organism was shown to be non-pathogenic for mice, rabbits and guinea pigs, and to have physiologic characteristics which differentiated it clearly from the pathogenic hemolytic streptococci. Specifically, it was shown to be markedly different from such pathogens as *S. pyogenes, S. equi,* the "animal pyogenes," and *S. mastitidis,* by its lower minimum temperature of growth, a higher maximum temperature of growth, a higher thermal resistance, and the ability to produce a lower final pH in glucose broth.

One object of this paper is to withdraw the previously applied name and suggest *Streptococcus durans* n. sp. as a more appropriate and convenient appellation. This name seems both suitable and descriptive in view of the organism's rather extreme tolerance to heat and desiccation. The former name is objectionable in that it might appear to imply a relationship to *S. thermophilus,* whereas further study of it shows that *S. durans* is in fact closely related to, and probably a member of, the "enterococcus group" of streptococci.

The more important reason for this paper is that the organism has now been studied with additional tests which are of value in showing more clearly its relationships to other streptococci, as well as expanding the description of the species.

In our former work it was shown that while this organism could be clearly differentiated from any adequately described species of streptococcus, it appeared to be most closely related to the *Streptococcus fecalis* group. Sherman and Stark (2) have shown that *S. fecalis* is able to grow in the presence of 6.5 per cent of sodium chloride, and also in media having an initial pH value of 9.6. Unpublished work in this laboratory has indicated that the ability to grow under either of these conditions is limited among the streptococci to the members of the enterococcus group—*S. fecalis, S. zymogenes,* and *S. liquefaciens. S. durans* grows in these concentrations of salt and alkali, thus showing its close relationship to the enterococci.

Sherman and Albus (3) used, among other tests, dilute medicinal methylene blue (1:20,000) in milk as a means of differentiating *Streptococcus lactis,* which was not inhibited, from *S. mastitidis,* which was inhibited. Avery (4) showed that this test also has an especial value in differentiating

certain non-pathogenic hemolytic streptococci from the pathogenic types. Recent work (5, 6) has further shown that if the concentration of methylene blue is increased to 1 part in 1,000 parts of skimmed milk, all of the better known streptococci are inhibited except *S. fecalis* and its relatives in the "enterococcus group," and *S. lactis* and its relatives in the "lactic group." *S. durans* is able to grow in the presence of a 1 to 1,000 dilution of methylene blue, which also indicates that it should probably be classed as an "enterococcus."

Other tests which were not used in the previous work are for the ability to produce ammonia from peptone and to attack esculin. *S. durans* produces ammonia from peptone and attacks esculin, again showing its general relationship to the members of the enterococcus group.

In the following description we have condensed all of the available information on the organism, including those characteristics previously reported.

THE CHARACTERISTICS OF STREPTOCOCCUS DURANS

General Characteristics

The cells occur in pairs, short chains, and more rarely in long chains. Blood is hemolyzed; gelatin is not liquefied; and there is no digestion of casein in milk cultures. Litmus milk is acidulated and curdled, there being no reduction of the litmus before curdling, and slow and incomplete reduction after curdling. It is not pathogenic for laboratory animals.

Significant Differential Characteristics

Growth takes place at 10° C. and at 45° C., the maximum temperature for growth being about 50° C. It survives heating at 62.8° C. (145° F.) for 30 minutes in skimmed milk, and usually survives the same exposure at 65.6° C. (150° F.).

Sodium hippurate is hydrolyzed; ammonia is produced from peptone; final pH values of 4.4 to 4.0 are attained in glucose broth; esculin is attacked.

Growth takes place in media with an initial pH of 9.6; also in the presence of 6.5 per cent of sodium chloride; and in a 1 to 1,000 concentration of medicinal methylene blue in skimmed milk.

Fermentation Characteristics

Glucose, maltose, and lactose are fermented. Raffinose, inulin, and glycerol are not fermented. Salicin is usually fermented (37 of 40 cultures), while mannitol is usually not fermented (5 of 40 cultures). Sucrose is rarely attacked, thus sugar being fermented by only one of the 40 cultures.

NOTE

A new and more appropriate name is suggested for a species which we had previously described under another name. The change is suggested on

the basis of a more extended study of the organism, and the desirability of the change is made clear in the foregoing discussion. We change this name with no apologies. It is of course true that the codes of botanical and zoological nomenclature place severe restrictions on such an action; but bacteriologists have not formally foresworn their liberties, though conforming in general to the rules governing other biologists. The complications which arise under a too strict slavery to such conventions is well illustrated in the confusion surrounding the name *Paramecium multimicronucleatum* (7).

SUMMARY

Streptococcus durans N. Sp is suggested as an appropriate name for the hemolytic streptococcus previously called *S. hemothermophilus*. The organism was studied by the application of more extensive tests, and a full description is given. Its close relationship to the enterococcus group of streptococci is established.

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American Dairy Science Association Announcements

THIRTY–SECOND ANNUAL MEETING, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA, JUNE 22–25, 1937

GENERAL INFORMATION

The meeting will open Tuesday, June 22, and Extension Section and Production Section meetings will be held on that day. A conference of the Manufacturing Section will be held on Tuesday and the Extension Exhibits are expected to be ready on that day. A special feature on Tuesday afternoon will be a session devoted to reproductive difficulties in cattle.

Registration will begin June 21 and rooms will be available in hotels, fraternity houses, and tourist camps at rates ranging from $1.00 to $2.50 per person. Full details of housing will appear later. It is hoped that the members will bring their wives and families and a program of entertainment will be provided for them.

CALL FOR PAPERS AND ABSTRACTS

The scientific program of the association will be conducted in special sessions, and the subject matter will cover fields of production, manufacturing, extension and instruction.

Members are invited to send the titles of their papers to the program committee chairman. Non-members are permitted to read papers only upon special invitation or if a member is co-author. Papers must represent original research that has not previously been published. Titles of papers must be either accompanied by or followed by the abstract. Titles of papers must be in the hands of the committee by April 20 and all abstracts by May 1. In submitting papers the author should indicate the group before which he prefers to have his paper presented, and he will be subject to the time limit of that session. In the sectional meetings the papers are to be limited to *12 minutes* with a *3-minute* period for discussion following each paper.

Please address communications about the program to Professor H. P Davis, Dairy Husbandry Department, University of Nebraska, Lincoln, Nebraska.

CHRONIC BOVINE MASTITIS AND MILK YIELD

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PRELIMINARY STATEMENT

This paper is a brief report in which milk yields of animals negative to mastitis diagnostic tests are compared to yields of the same animals after they had become positive to these tests.

It is now taken for granted that cows yielding abnormal milk, as a result of udder infections, should have no place in a dairy. Moreover, dairymen have learned through experience that the quantitative yield of clinically affected cows has become, or may be destined to become, so diminished as to render them unprofitable.

With the development and improvement of diagnostic tests it is now possible to detect mastitis in its incipient stages before udder symptoms or abnormal milk become evident to the casual observer. These tests are now being used extensively to control and eradicate mastitis, so it is of great importance to the owner of dairy cattle to know to what extent mastitis both in its incipient and chronic stages adversely affects the volume of production. Evidence has begun to appear on this question but as yet only a few reports bear definitely on the problem as here presented.

Ernst, Klimmer, and Rudolf, as quoted by Seelemann (6), estimate that milk yield is reduced about 10 per cent (Rudolf 500 pounds in Austria) by mastitis. Seelemann (6) made a comparison of infected quarters with the corresponding opposite quarters of the udders of twelve cows and found a small reduction in yield. However, Seelemann states that occasionally the total yield of the udder was apparently normal, possibly as a result of compensation made by the normal quarters.

Shaw and Beam (7) have recently reported on a study of 86 cows over one year in which infected quarters were compared to the corresponding opposite quarters. Their study shows that the normal quarters yielded 2.3 pounds of milk and 0.1102 pound of fat testing 4.79 per cent, and the infected quarters yielded 1.5 pounds of milk and .0723 pound of fat testing

4.82 per cent. After correcting for natural differences in yield of front and rear quarters (4:5.1, Seelemann), Shaw and Beam estimated a reduction of 22 per cent in milk and 24 per cent in fat due to infection. The tests employed were bromthymol blue, chloride, leucocyte, and catalase and quarters were pronounced infected when reacting to not less than three of these tests.

Still more recently Minett and Martin (2) have reported on three large herds, one Ayrshire and two Holstein, in England, seriously infected with mastitis and infectious abortion, and occasionally also with tuberculosis and Johne's disease, but corrections for these troubles were made as carefully as possible by the authors. "Cows were classed as 'mastitis infected' (a) when one quarter of the udder at least was definitely infected with *Streptococcus agalactiae*, irrespective of herd history, (b) when the milk was definitely abnormal at one or more examinations as regards reaction of centrifuge deposit, even although recognizably pathogenic bacteria were not demonstrable, but only if the owner could state the animal had suffered from udder trouble." Exclusion of all doubtful cows was rigorous. The reduction in yield in the Ayrshire herd was 10.8 per cent; and in the Holstein herds 16.5 and 19.5 per cent respectively.

SOURCE OF DATA AND METHODS

The data presented here were from yields and tests in the Connecticut State College dairy herd and in one farmer-owned herd. A few of the College herd records extend back to 1926 when pooled udder samples were studied, but since 1931 the data have been derived from separate quarter samples. During this period several diagnostic tests have been studied, as previously described in bulletins and papers from this Station (3, 4, 5). Four tests employed consistently have furnished the basis for this study, namely: identification of organisms; bromthymol blue test; leucocyte count, and sediment test. The interpretation of these tests has been described in the bulletins noted above.

The herds have been free from tuberculosis consistently and from Bang's abortion disease for the greater part of the period under consideration. The herds have not been widely troubled with any other disease so far as is known. Only animals that have to their credit both one or more normal lactations and one or more lactations while reacting to the diagnostic tests have been included. These criteria thus have eliminated all animals that have never reacted positively to mastitis, as well as a very few that became infected or suspicious during the first lactation. Altogether the records present an experience with 30 cows in the College herd and 22 cows in the farmer's herd, a total of 90 normal and 108 infected lactations of the same animals.

In both herds animals whose udders were badly involved and whose yields were obviously diminished thereby were disposed of in routine management, so this study is chiefly concerned with incipient and mild cases of the disease and not with severe and acute ones.

In the College herd there are Ayrshires, Guernseys, Holsteins, and Jerseys, and in the farmer's herd Holsteins only.

Because of varying length of lactations and time of breeding and conception, the yields of only the first 240 days of the lactation have been employed. All records have been corrected to full age, using breed association conversion factors. The records of the College herd are presented on a basis of three milkings a day, as this was the most frequent milking pattern in the herd, while in the other herd, the records having been made on two milkings, the data are presented on that basis. Records in the College herd made as Advanced Registry or Register of Merit tests were subjected to a further reduction of 11 per cent, after Fohrman (1), to correct for conditions somewhat more favorable than applied in the other lactations. There is some room for doubt about the magnitude of the influence to be attributed to Advanced Registry and Register of Merit management in this herd, but the conditions are admittedly somewhat more favorable for production. Having no more accurate data than the 11 per cent factor it has been applied. Corrections for differences in butterfat test of individual cows was not necessary inasmuch as with these data each animal appears both as a normal and as an infected animal.

<center>RESULTS</center>

The normal yield for the animals in the College herd was 9557 pounds of milk. The yield when reacting to mastitis tests in one or more quarters was 9094, a loss of 463 pounds of milk or 4.84 per cent.

The reader should be reminded that these animals did not necessarily display clinical evidence of infection, especially in the first lactation of infection; also, that an animal was pronounced infected even though only one quarter showed evidence of infection by the laboratory criteria.

Twelve animals show a higher yield and 18 a lower yield after giving evidence of infection. The effect on yield in the incipient and latent stage of infection is therefore not consistent, and as suggested by others, may be compensated by the normal quarters.

The data for the farmer's herd are similar. There was an average loss in yield of 425 pounds of milk, in which 14 of the 22 cows experienced a loss in production.

Judged by the evidence so far presented, one would be forced to the conclusion that from a purely economic standpoint a farmer is scarcely justified in sacrificing animals solely because of the test. This conclusion would stand were it not that other factors are involved. Infection usually

becomes more severe and tends to spread to all quarters as the animal advances in age. *In these two herds it is the usual practice to dispose of badly infected cows. Obviously if such animals had been kept longer in the herd more striking effects on production would be in evidence.* All dairymen who have encountered mastitis are quite aware of this. Thus, the infected group has been favored in the evidence by the disposal of pronounced cases.

The data have been further broken down on the basis of number of quarters involved. The condensed data for the College herd are presented in Table 1.

TABLE 1

Comparison of production by animals in normal and infected lactations

NORMAL	QUARTERS INFECTED				GAIN OR LOSS
	One quarter	Two quarters	Three quarters	Four quarters	
9196	9307				+ 111
10061		9721			− 340
11009			10194		− 815
9183				8137	− 1046

No loss is shown with one quarter involved but with two, three, and four quarters the loss is progressive from 340 with two quarters to 1046 pounds, or 11.4 per cent, with all four quarters reacting.

In the farmer's herd the results are similar, there being a loss of 27 pounds with one quarter reacting and a loss of 1063 pounds with four quarters involved.

The data on the College herd were then tabulated and studied on the basis of tests employed. These results are presented in the following table.

TABLE 2

Evidence of mastitis and milk yield on basis of tests used

	SEDIMENT TEST	BROMTHYMOL BLUE	LEUCOCYTE COUNT	INFECTION WITH STREPTOCOCCUS MASTIDITIS
Normal	9689	10075	9841	8972
Positive	9093	9238	9268	7872
Loss	596	837	573	1100

It is generally known that the diagnostic tests here employed do not agree in all instances, but rather that they supplement each other. When the data are studied from the standpoint of each individual test some differences are noted. Those giving positive evidence to the sediment test showed a loss in milk of 596 pounds; to the bromthymol blue test 837 pounds; those with high leucocyte count 573 pounds; and those infected with *Strepto-*

coccus mastiditis 1100 pounds. The loss in the latter case was 12.26 per cent.

The above table is a composite of results with one to four quarters involved. In cases where all four quarters were involved the sediment positives showed a loss of 723 pounds, the bromthymol blue positives 1360 pounds, the leucocyte positives 1627 pounds, and the *Streptococcus mastiditis* positives 1100 pounds. From this it seems that the sediment test (0.5 per cent or more sediment by volume) is the least significant of the four tests from the standpoint of complete glandular involvement, which confirms a conviction previously arrived at regarding this test.

DISCUSSION

The detailed data present some peculiar and interesting evidence. A few cows with latent infection have reacted over a period of years and yet have not suffered in yield so far as is evident. Add to this the practice of eliminating from the herd animals showing aggravated clinical symptoms of mastitis and it is seen that the evidence is biased to the advantage of mastitis reactors. During the past seven years 40 cows from the College herd have been sold to the butcher. Twenty-five of these were reactors to mastitis tests and 15 at the time were producing a mere fraction of their normal yield.

At first thought it would seem that the loss in yield due to mastitis shown in this study is much below that reported by Shaw and Beam (7) and others. However, only animals with four quarters involved are comparable with the Shaw and Beam results, since these authors reported only on infected quarters. The loss in all four quarter cases amounts to 15 to 20 per cent by our data.

Lactation yields of three infected cows are presented in Graphs 1, 2, and 3 to show variation in performance. The normal lactation expectancies are those developed by Larro Research Farm.[2]

Graph 1 describes the production of Radiant Romance Storrs, a Jersey cow. This is a case of latent infection of long standing. During her first lactation, starting on February 14, 1925, no observations were made. She again calved August 31, 1926, and pooled quarter sample tests were begun in December of this year, in which she was normal. Calving again October 12, 1927, she was normal throughout this lactation. These first three lactations are combined therefore to represent a disease-free performance with an average yield of 9474 pounds.

In the next two lactations this cow was positive, based on pooled sample tests. The average yield was 7942 pounds. These lactations are combined on the graph. During the next five lactations the cow was positive to

[2] Interpretation of milk production by use of standard production graphs. Charles Staff, Larro Research Farm, Detroit, Mich.
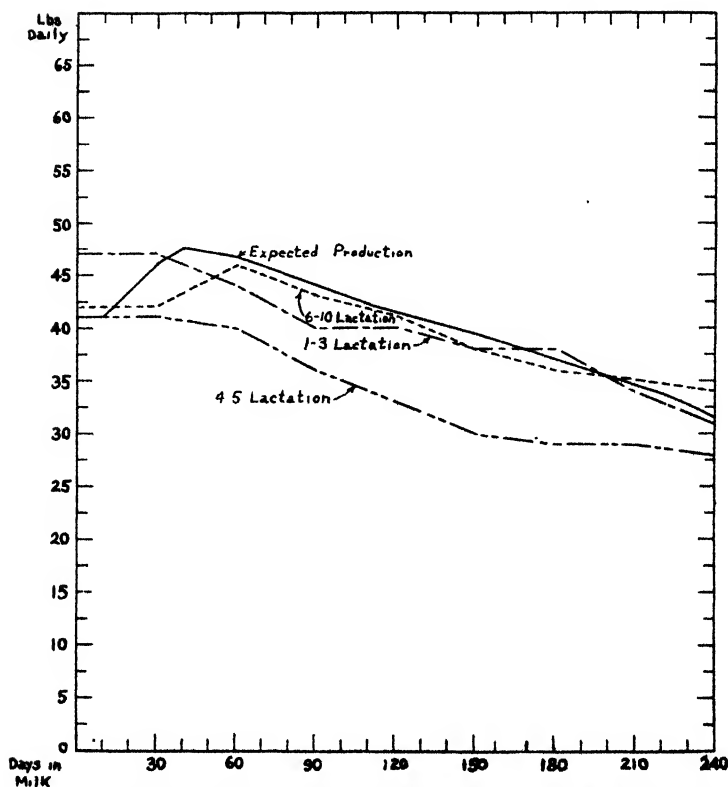
GRAPH 1. Radiant Romance Storrs. During lactations 1 to 3 she was assumed to be normal and the average mature equivalent milk yield was 9474 pounds; during lactations 4 and 5 she was positive to pooled udder samples and the average yield was 7942 pounds; during lactations 6 through 10 she was positive in all four quarters and milk yield was 9454 pounds.

quarter sample determinations and these results are combined into one curve on the graph. The average yield was 9454 pounds.

This cow has shed long chain streptococci from all four quarters during the last five lactations and yet her yield has apparently been unaffected. In the full year's test just completed she produced over 15,000 pounds of milk (actual, no conversion factors applied), the highest record of her career.

This is one of a half dozen somewhat similar cases in the herd which of course has favored the infected group, since no animal whose yield was decidedly affected remained long in the herd to offset these cases .

Graph 2 presents the case of the Holstein cow Seneca Papoose Storrs. Her first calving was on May 17, 1930, and she completed four lactations, the fifth being terminated by her elimination from the herd.
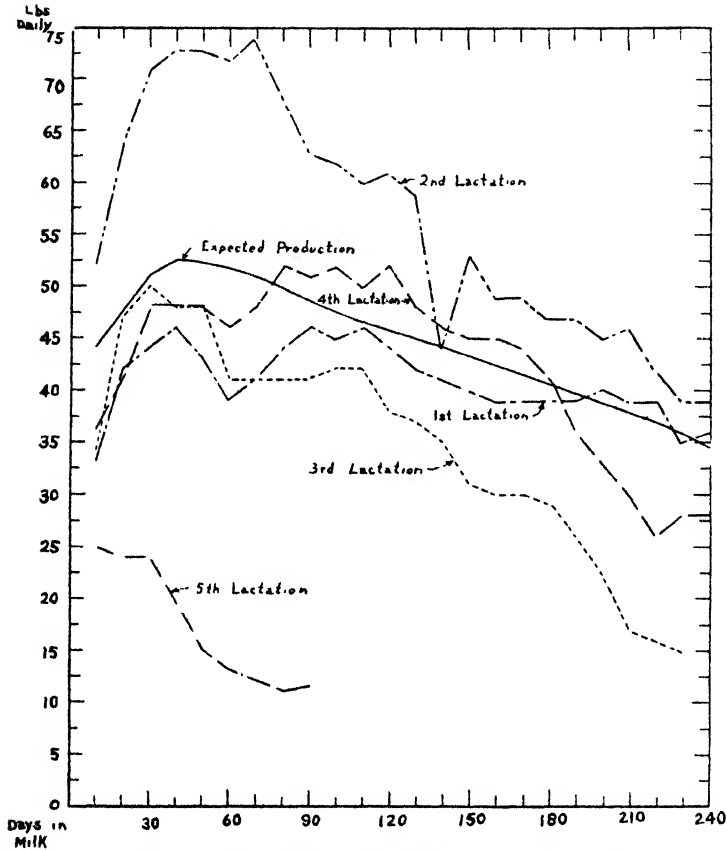
GRAPH 2. Seneca Papoose Storrs. Suspicious to pooled udder samples during her first lactation and produced 9800 pounds; in the second lactation she was positive in all four quarters and produced 13,536 pounds; in the third lactation she was suspicious in one quarter and positive in the other three and produced 7996 pounds; in the fourth lactation she was still positive in three quarters and suspicious in the other and produced 10,181 pounds; in the first 92 days of the fifth lactation she produced 1580 pounds of milk, all of which was discarded because it was thick and bloody from three quarters that were shedding streptococci. The fourth quarter was shedding staphylococci and the milk appeared normal.

During her first lactation she shed staphylococci intermittently and was classed as suspicious. In her second lactation she shed staphylococci constantly from all quarters and was classed as positive. She also showed clinical symptoms at times. Her first lactation coincided on the whole with the curve of expectation, while her second performance exceeded normal expectations, although there were two sharp breaks in the production curve, both of which she overcame.

In her third lactation she shed streptococci from three quarters and staphylococci from the fourth quarter in all samples tested. Her performance here was considerably below expectations. In her fourth the laboratory evidence was similar to the previous lactation. A comeback was made, but in this case the production curve is too wavy for a normal performance.

The fifth lactation was a complete failure and the cow was eliminated after three months. The milk from three quarters shedding streptococci was thick and bloody, while the right front quarter, still shedding staphylococci, yielded normal-appearing milk.

This cow's record is not included in the summarized data as she did not have a completely disease-free lactation.

Graph 3 presents the case of a Guernsey, Splendent Sagacious Storrs. She calved first on February 13, 1930, and was negative to mastitis during the first lactation. Her performance was above expectations.
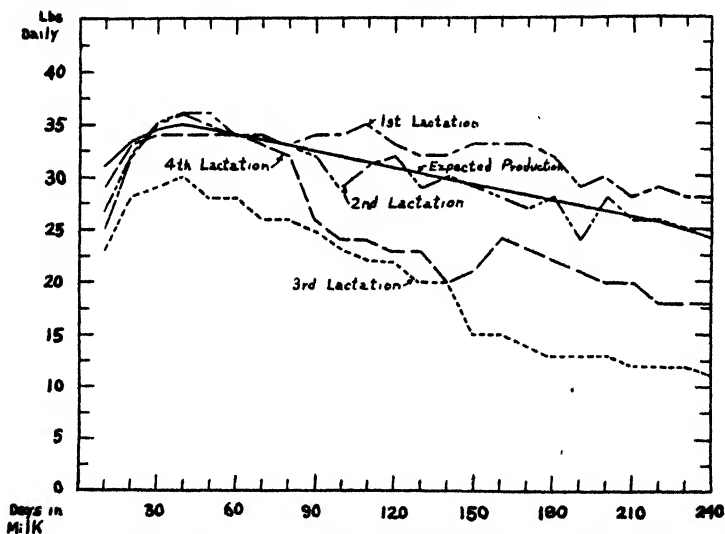
GRAPH 3. Splendent Sagacious Storrs. Negative to all mastitis tests in the first lactation and produced 7663 pounds; in the second lactation she was positive in one quarter and produced 7115 pounds; in the third lactation she was positive in three quarters and suspicious in the other and produced 4793 pounds; in her last lactation (4th), after a long dry period, she recovered somewhat from the attack of mastitis and was positive in only one quarter, producing 6100 pounds. She did not conceive again.

During the second lactation this cow, freshening in April, 1931, showed clinical symptoms in the right front quarter in October and November, accompanied with a high leucocyte count and staphylococci organisms. Her performance was not as good as in the previous period but coincided well with the curve of expectation.

In the third lactation *S. mastiditis* was shed intermittently and her yield was much below expectations, the curve of decline being quite sharp. In the fourth lactation, after a long dry spell as a result of failure to conceive promptly, all the quarters were negative to the tests except the left hind quarter which shed *S. mastiditis* throughout. The cow made partial recovery in yield but the curve of production was below normal, especially between the second and sixth months.

This cow did not conceive again.

SUMMARY

Observations on the production of animals before and after the development of laboratory evidence of mastitis were made. These data are derived from animals in the early stages of infection and animals in which the disease was latent in character. In many cases no clinical evidence was observable during most of the mastitis reacting periods.

Since animals showing obvious clinical evidence of mastitis were eliminated from the herds as a matter of routine practice before the full impact of chronic mastitis on production of milk was manifested, it is evident that the full adverse effect on yield is not here measured. Rather, these data tend to show that a loss in yield may occur in the majority of cases during the incipient stage of the disease.

In 240-day lactations of a group of 30 cows having a history both as mastitis free and mastitis positive based on the bromthymol blue test, the sediment test, the leucocyte count, and the shedding of organisms, there was a loss of 463 pounds of milk attributable to mastitis. In another herd of 22 cows there was a loss in yield of 425 pounds. These reductions are between 4 and 5 per cent and are not particularly significant. A loss in yield was manifested in about two thirds of the individual cases.

When only one quarter was positive there was no loss in yield. Such are usually incipient stages, and possibly also compensation in yield is made by the unaffected quarters. The loss, however, increased in magnitude with each additional quarter involved amounting to about 15–20 per cent with all four quarters positive.

When the results were segregated for each diagnostic test it was found that for those reacting to the bromthymol blue test the loss in yield was 837 pounds, and for those shedding *S. mastiditis* the loss· amounted to 1100 pounds per lactation. The loss in yield of sediment positives was 596 pounds and of leucocyte positives 573 pounds.

No effect on the butterfat percentage was observed.

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THE OXIDATION OF BUTTERFAT

I. THE CATALYTIC EFFECT OF LIGHT*

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It is commonly known that when dairy products and foods containing fat are exposed to light they develop off-flavors more rapidly than when protected from the light. This increased tendency to develop off-flavors is due to the effect of light in accelerating the oxidation of the fat. A package used for merchandizing of dairy products and foods should give good protection against the development of off-flavors and yet display the product to its best advantage. Undoubtedly, certain rays of light should be excluded in order to protect the fat from oxidation.

REVIEW OF LITERATURE

Probably the first scientific report on the effect of light was made by Duclaux (1) in 1889 when he obtained a tallowy flavor and odor by the exposure of pure butterfat to air and light. By 1890 Ritsert (2) had established that rancidification was an oxidative change which required only the presence of oxygen and which could be accelerated by light. In 1899 Browne (3) observed that exposure of the fat to light was an important factor in the production of rancidity.[1] Wagner, Walker, and Oestermann (4) (1913) claimed that light alone, in the absence of air, was capable of producing rancidity. Hunziker and Hosman (5) showed that light was a factor in promoting the development of a tallowy flavor in butter.

Hammer and Cordes (6) found that sunlight had a pronounced influence on the flavor of milk and cream and that it also produced tallowy flavors in other dairy products. These abnormal flavors produced in dairy products by exposure to sunlight in ordinary glass bottles could be prevented by the use of brown glass bottles. Milk and cream that had been exposed to sunlight in ordinary glass bottles yielded a much lighter colored fat than milk or cream from the same lot unexposed. Off-flavors were observed in certain samples of milk after an exposure of only 10 minutes, while definite tallowiness was observed with exposures as short as 45 minutes.

Emery and Henley (7) found that light was necessary for the development of rancidity in fats exposed to air and not in contact with metals, but fat stored in contact with metals developed rancidity even when protected from light. In other words, light in the absence of metals appeared to exert

[1] As used in this paper, the term rancidity refers to oxidative rancidity.

the same effect as was exerted by metals in the absence of light.   These experiments were carried out with lard.

Holm, Greenbank and Deysher (8) found that exposure of fats to ultra-violet light greatly decreased the induction period of oxidation.

Frazier (9) concluded that the catalytic action of sunlight in the oxidation of milk fat will produce the cardboard taste and the linseed oil odor in a few hours.   Although the heavy glass of the milk bottles screened out the ultra-violet rays, it allowed the passage of active longer rays which exerted a catalytic effect.

Davies (10) found that light favored a short induction period and that the finely dispersed fat in milk would deteriorate sufficiently on an exposure of 2 minutes to the radiations of a small mercury vapor lamp so as to be detectable by taste, while after 10 minutes exposure the milk was almost undrinkable.

Briggs (11) states that ultra-violet light has a strong oxidative effect on butterfat.

Tracy and Ruehe (12) report that sunlight and diffused light are important factors in the development of tallowiness in milk, especially if the milk contains an added copper salt.

In his experiments with beef fat Lea (13) showed that the oxidation was autocatalytic and that a reduction of the light intensity 50 times only reduced the resultant oxidation about 5 times,   Even a weak light exerted an appreciable influence on the oxidation.   He found also that the difference in the susceptibility of fats to oxidation was due to differences in the chemical nature of the fat and that oxidation in the earlier stages had very little effect upon the free acidity of the fat.   Bleaching occurred at an early stage in the oxidation.

Whitehead (14) found that sunlight caused the development of a reducing potential in milk which could be measured either by its effect on methylene blue or by electrometric measurements.   Ultra-violet radiations from a mercury vapor lamp were far less effective than sunlight.   This investigator concluded that the agent inducing the oxidation of fat in milk was probably some portion of visible light of which there was less in the radiations of a mercury vapor lamp than there was in sunlight.   Radiations from an electric lamp were negative so far as any effect on the oxidation of the fat or reduction of methylene blue were concerned.

Anderson and Triebold (15) found that butter from irradiated milk had a shorter induction period for oxidation than that from non-irradiated milk.

Coe and LeClerc (16) exposed butter for 17 hours to the action of light rays produced by a monochromator having a range from 3020 to 5461 Å.   A test of the butter thus subjected to the various wave lengths of light showed a positive reaction for rancidity with the modified Schiff's reagent in every case except where the butter had been acted upon by green light of a range

of approximately 5461 Å. These experiments were repeated with glass color filters. Here again it was shown that covering with a green wrapper, which removed practically all radiations except those in the range of 4900 to 5600 Å, exerted a protective action as judged organoleptically as well as with the von Fellenberg test for rancidity. Experiments with rice bran showed that oxidation in the absence of light did not hasten rancidity and that the addition of copper or iron was ineffective unless exposed to light. Where the air was excluded with carbon dioxide rancidity appeared in the sample exposed to light but not in the sample wrapped in black. Potato chips in an ordinary bag became rancid in two weeks while chips in a green bag were not affected Samples of the oil used in making these chips were placed in containers, one protected from light with a black wrapper, and the other not protected. The unwrapped sample gave weekly test for peroxide values of 8, 49, 74, 101, and 207, while the tests of the oil wrapped in black were 8, 17, 29, 31, and 36.

Baumann and Steenbock (17) have shown that the points of maximum absorption in butteroil occurs at 460 and 485 mu.

Coe and LeClerc (18) have come to the following conclusions: "As the result of continued exposure to light an oil on becoming rancid has a peroxide value characteristic of that oil. When properly protected from light this oil may develop a much higher peroxide value without becoming rancid. An oil, protected from light and having an abnormally high peroxide value will, on exposure to light, become rancid. It is the light that causes the changes which give rise to rancid odor and taste; it is possible that these same changes are formed independent of the cleavage products of an oil, which heretofore, have been considered responsible for rancidity."

Ruemele (19) has pointed out that it is the action of light and the composition of the fatty acid mixture that determines the speed of fat spoilage.

Henderson and Roadhouse (20) found that exposure of cream to direct sunlight and to diffused light gave definite increases in the susceptibility of the fat to oxidation and that the direct sunlight had the greatest influence on the oxidation.

Francesconi and Piononcelli (21) demonstrated that olive oil, peanut, sesame and colza oils were not affected by ultra-violet in the presence of air.

Coe and LeClerc (22) have obtained the following results:

If cottonseed or corn oil was protected from light by wrapping the glass containers with metal foil, opaque black paper or a green wrapping material whose permeability to light is limited to the interval from 4900 to 5899 Å rancidity did not appear even though the peroxide value reached approximately 60 millimoles per kilo of oil. If the oil had not been protected from light, rancidity appeared at this stage. Experiments showed that a protected oil may have a peroxide value of nearly 200 without being rancid as determined organoleptically.

Experiments with oils irradiated by means of color filters selected so that successive portions of the visible spectrum were absorbed showed that blue light was more conducive to the formation of peroxides and the development of rancidity than the red end of the spectrum for the same period of irradiation. The development of rancidity does not necessarily parallel the formation of peroxides. Containers or wrappers designed for enclosing oil-bearing foods should exclude both ends of the visible spectrum, more especially the blue, in order to prevent or delay the development of rancidity. The color which affects the development of rancidity the least is green, delimited by 4900 to 5800 Å.

These investigators (30) found also that maleic acid, phthalic acid, hydroquinone, pyrogallol, cathechol and guaiacol were not as effective in delaying the development of rancidity as green wrappers which transmitted light delimited by 4900 to 5800 Å.

Coe and LeClerc (23) point out that air may be bubbled through cottonseed oil in a clear flask and a green flask and that they will have approximately the same peroxide value at the end of the experiment, yet the oil in the green flask will be free from rancidity and the other will be rancid. The oil in a blue flask had a higher peroxide value than that in the clear flask at every stage of the experiment and also became rancid at an early stage. The disappearance of ability to absorb blue light apparently is accompanied by the development of rancidity. These authors concluded that the well-known color tests for rancidity and the peroxide test were not reliable when applied to oils which have been properly protected from light.

In the experiments of Davies (24) it was found that light passing through cellophane colored a deep blue, deep green, deep brown and deep red did not cause an appreciable increase in the peroxide oxygen of the fat of biscuit meal even after exposure to direct sunlight for 40 hours. Light green and heliotrope cellophane wrappings caused some autoxidation to occur, while light blue, pink, lemon and orange colored cellophane wrappings allowed practically the same amount of oxidation to occur as by direct exposure. He concluded that in order to preserve the fat of fatty foods wrapped in cellophane, it is on the whole, the depth of color and not the actual color which is of importance.

Morgan (25) found that blue and invisible ultra-violet light materially accelerated the development of rancidity in such materials as potato chips, crackers, cakes, butter, candies, nuts and soaps, whereas other visible light such as red and yellow had very little effect. Consequently rancidity-retarding wrappers may be of any visible color except blue.

Schlemmer (26) tested various ordinary parchments and "ultrament," a special parchment for protecting foods from light, for absorption of light between 4000 and 2000 Å. His conclusion was that of all the parchments only "ultrament" protected foods from ultra-violet light.

Kieferle and Seuss (27) found that the oxidation of butter wrapped in various materials and exposed to light decreased in the following order: uncovered, parchment paper, cellophane, ultrament paper, tin and aluminum foil. The tendency of the butter to bleach under various wrappers increased in the following order: metal foil, yellow cellophane, ultrament, colorless cellophane, parchment and uncovered.

<div style="text-align:center">EXPERIMENTAL PROCEDURE</div>

It is now quite universally accepted that the formation of peroxides is one of the first stages in the oxidation of a fat and that the peroxide oxygen increases as the oxidation proceeds. The amount of peroxide oxygen present in a fat serves as an excellent criterion of the degree of oxidation of that fat. The peroxide number of a fat is defined as the number of millimoles of active or peroxide oxygen in combination with one kilogram of the fat. The method proposed by Wheeler (28) was used in these trials for determining the peroxide number of the butterfat.

The color of the butterfat was measured by comparison with standard solutions of potassium dichromate and is expressed as the number of millimoles of potassium dichromate per liter of water.

In testing the effect of light on the oxidation of butterfat ten cubic centimeter samples of butteroil were exposed in 9 cm. Petri dishes. The layer of fat was about 1.57 mm. in depth. Samples were removed at the times designated in the tables and were tested for peroxides, color, and flavor. The intensity of the radiations from the ultra-violet lamp was checked with a Hanovia Ultra-Violet Meter.

The following wrapping materials were tested for their ability to prevent the oxidation of butterfat when exposed to light.

1. Aluminum foil
2. Glass—Petri-dish cover
3. Parchment—ordinary butter wrapper parchment
4. Pliofilm—a rubber composition
5. M. A. T.—uncolored, moisture and fat proof cellophane
6. M. R. T.—special light filtering cellophane
7. Pink cellophane
8. Tango cellophane—golden brown color
9. Dark blue cellophane
10. Dark red cellophane
11. Dark green cellophane

A. *The Oxidation of Butterfat in the Absence of Light*

It has been reported that certain fats did not show oxidative rancidity, as determined organoleptically, when protected from light, even though they had attained a high peroxide number. It is a matter of practical experience

that butter and frozen cream in cold storage and protected from light will frequently develop a tallowy flavor even though care had been taken to prevent metal contamination.

To test this point and to follow the changes during the oxidation of the fat a flask containing butteroil, and protected from light, was held at a temperature of 98.5° C. in a boiling water bath while air was bubbled through the fat at a rate of approximately 50 cc. per minute. The air was washed, first with sulphuric acid, and then with potassium hydroxide. The exhaust air from the fat was allowed to escape through a flask containing about 200 cc. of water and phenolphthalein indicator.

Samples of the fat were removed at regular intervals and tested for peroxide number, color and flavor. At the same time the water in the exhaust aid flask was titrated with standard alkali to the end point of phenolphthalein. The acidity is expressed as the number of cubic centimeters of N/14 sodium hydroxide required to neutralize the volatile acids from a kilogram of butterfat. At the end of the working day, the fat was quickly chilled and protected from light until the next day, as the oxidation was carried on for 200 hours.

The results of this trial are shown graphically in Figure 1. The presence
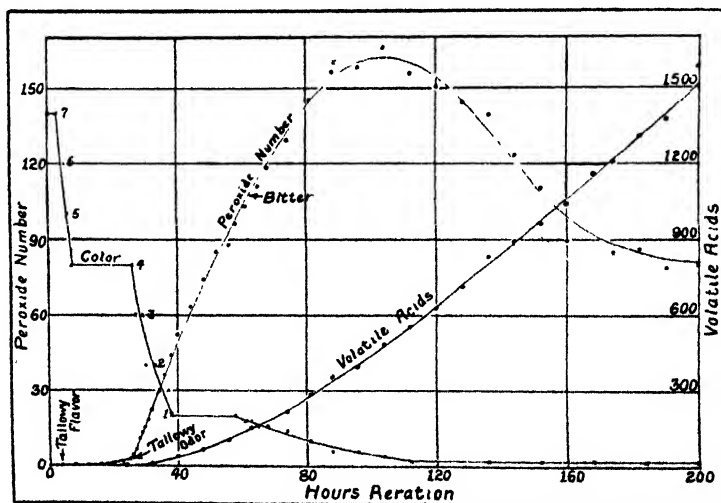
FIG. 1.   THE OXIDATION OF BUTTERFAT BY AIR AND HEAT IN THE ABSENCE OF LIGHT.

of peroxides was first detected at the end of 3 hours at which time the peroxide number of the fat was 0.05. The peroxides continued to develop slowly up to 25 hours, the end of the induction period, and then rapidly until a maximum peroxide number of 166.1 was reached at the end of 104 hours, after which the peroxide value decreased at about the same rate as it

had increased until the end of the 160th hour. After this period the melted fat was becoming noticeably more viscous than it was at the beginning.

The bleaching of the color was first observed at the end of 4 hours and was then quite rapid for the next 3 hours, after which it did not change until after the 26th hour when there was another period of rapid bleaching. The color then remained constant for 20 hours, after which there was a gradual bleaching to the 106th hour at which time it was equivalent in color to a solution containing 0 1 millimoles of potassium dichromate per liter. This melted fat retained the faint tinge of yellow until the end of the oxidation period, although the solidified fat was white.

The development of volatile acids was slow until after the 30th hour when the increase became quite rapid until the end of the oxidation period. As might be expected, the rapid increase in volatile acids occurred a few hours after the rapid rise in peroxides as the acids are the result of a secondary reaction after the formation of peroxides.

The end of the induction period is well marked by the rapid bleaching of the fat, the rapid increase in peroxide value and the subsequent increase in volatile acids. This latter fact has been used by the authors (29) for approximating the end of the induction period with the accelerated Swift fat stability test.

At the end of the 2nd hour the fat had a slight off-flavor, but was not tallowy. A slight tallowy flavor appeared at the end of the third hour along with the first test for peroxides. However, in other trials, the tallowy flavor did not always appear at the same time the first test for peroxides was obtained, but varied with the different samples of butterfat. In some instances a peroxide number of 6 or higher was reached before the fat was distinctly tallowy. A tallowy odor was not evident until the end of the induction period.

B. *The Catalytic Effect of Light on the Development of Peroxides and Tallowy Flavor in Butterfat*

1. *The oxidation of butterfat by radiations from the quartz mercury-vapor lamp.*

Changes resulting from the oxidation of butterfat under the quartz mercury-vapor lamp are shown graphically in Figure 2. The intensity of the radiations was kept constant at 800 microwatts/cm²/sec. (3200–1850 Å). Along with the first test for peroxides at the end of 5 minutes, the fat had a slight off-flavor characterized as an "ozone flavor" but was not tallowy. At the end of 15 minutes the fat was distinctly tallowy, but the flavor resulting from exposing the fat to ultra-violet light was somewhat different than that resulting from the oxidation of the fat in the absence of light.

The catalytic effect of ultra-violet light practically eliminated the induction period as the rapid development of peroxides occurred almost from the
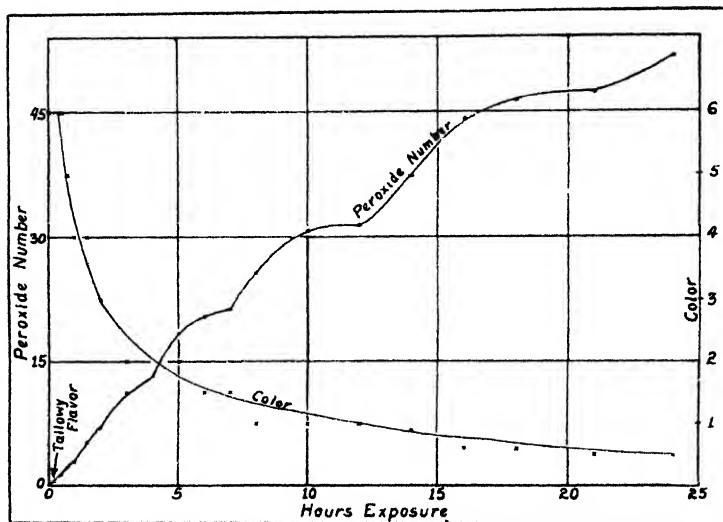
FIG. 2.   THE OXIDATION OF BUTTERFAT UNDER THE QUARTZ MERCURY-VAPOR LAMP.

beginning.   The development of peroxides (Figure 2) occurred as a series of waves, the nodes increasing in length as the time of exposure increased.

The most rapid bleaching of the fat took place during the first few hours of exposure.

2.   *The oxidation of butterfat by sunlight.*

Figure 3 shows the development of peroxides and the bleaching of butterfat when exposed to sunlight.   The first positive peroxide test was obtained at the end of 2 minutes but the butterfat did not have an off-flavor until it had been exposed 15 minutes.   As in the case of ultra-violet light, the induction period was practically eliminated and the development of peroxides followed a wave motion.   As the period of exposure to sunlight increased the dips in the waves represented a considerable decrease in the peroxide number only to come back again for a higher crest than the preceding one and again followed by another dip.   These crests and dips cannot be attributed to the change in intensity of the sunlight or to the periods during which the fat was not exposed to the light.

The bleaching of the fat was very rapid during the early stages of the oxidation and at the end of 20 hours the melted fat was water clear.

3.   *The oxidation of butter fat by diffused daylight.*

Exposure of butterfat samples to diffused daylight on the north side of a building also hastened the oxidation of the fat, but the reaction was much slower than in the case of sunlight.   At the end of $12\frac{1}{4}$ hours the butteroil was very strongly tallowy and had a peroxide number of 2.2.
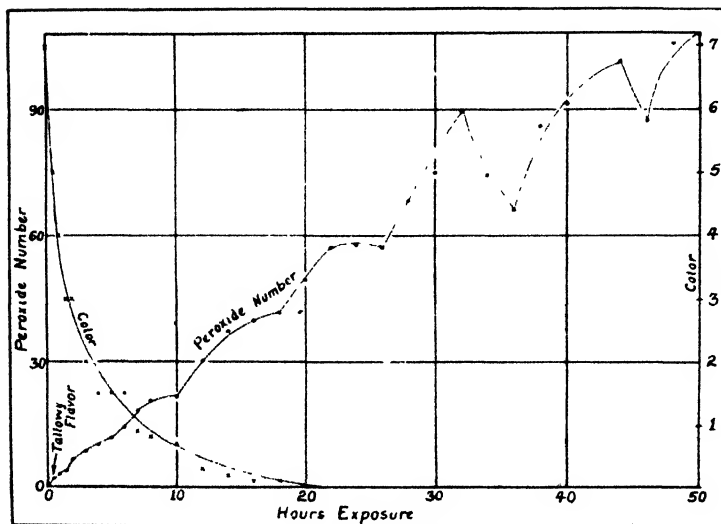
FIG. 3.   THE OXIDATION OF BUTTERFAT BY SUNLIGHT.

4. *The oxidation of butterfat by lamplight.*

Butterfat samples developed peroxides and became tallowy when exposed to a 100 watt bulb at a distance of 10 centimeters.   The reaction was much slower than with diffused daylight but at the end of 4 days' exposure the samples were very tallowy and had a peroxide number of approximately 2.0.

5. *The oxidation of butterfat by infra-red light.*

Exposure of butteroil samples to an infra-red lamp for 14 hours failed to produce a tallowy flavor even though the peroxide number had increased to 0.8.   Longer periods of exposure were not carried out due to the high temperature (112° C.) attained by the fat.

C. *The Protective Action of Wrappers*

The preceding experiments showed that the sources of light which were high in ultra-violet were most effective in catalyzing the oxidation of butterfat.   Various materials which might be used for protective coverings for butter were tested with the Hanovia ultra-violet meter for their ability to screen out light rays from 3200 to 1850 Å.   Due to the fact that this instrument is affected somewhat by visible and infra-red light it cannot be used for comparing the strength of the ultra-violet in sunlight with that from a quartz mercury-vapor lamp.   Although the results are not absolutely quantitative, the Hanovia meter was used in these trials to compare the ability of single sheets of the various wrappers to shut out the short rays from sun-

light and from an ultra-violet lamp.   Tables 1 and 2 show the intensities
of the light under the various wrappers as well as the peroxide number and
the flavor developed in the butterfat by exposure of butteroil to the quartz

TABLE 1

*The protective action of various wrappers on the oxidation of butteroil when exposed to
the radiations from a quartz mercury-vapor lamp*

WRAPPER (ONE THICKNESS)	INTENSITY MICRO-WATTS/CM²/SEC. 3200–1850 A	BUTTEROIL	
		4 hours' exposure peroxide number	4 hours' exposure flavor
1. Aluminum foil	0	0.0	OK
2. Dark red cellophane	12	0.29	OK
3. M. R. T. cellophane	40	0.68	Sl. off-flavor not tallowy
4. Dark green cellophane	84	1.42	Sl. tallowy
5. Petri dish cover	600	4.18	Tallowy
6. Dark blue cellophane	400	5.52	"
7. Parchment	332	5.64	"
8. Tango cellophane	240	7.21	Purplish discoloration of cellophane. Tallowy
9. M. A. T. cellophane	620	8.69	Tallowy
10. Pliofilm	660	8.94	"
11. Pink cellophane	620	11.60	"
12. No covering	800	13.01	"

TABLE 2

The protective action of various wrappers on the oxidation of butteroil by sunlight

WRAPPER (ONE THICKNESS)	INTENSITY MICROWATTS/CM²/SEC. 3200–1850 A	4 HOURS' EXPOSURE PEROXIDE NUMBER	4 HOURS' EXPOSURE FLAVOR
1. Aluminum foil	0	.0.0	OK
2. Dark red cellophane	990	1.6	OK
3. Dark green cellophane	1120	1.7	OK
4. Tango cellophane	1540	3.6	Sl. tallowy
5. M. R. T. cellophane	1280	5.1	Sl. tallowy
6. Dark blue cellophane	2120	7.3	Tallowy
7. Parchment	1560	7.8	Tallowy
8. Pink cellophane	2640	Lost	
9. Glass	3240	13.6	Tallowy
10. Pliofilm	3040	14.3	Tallowy
11. M. A. T. cellophane	3240	15.1	Tallowy
12. No covering	3680	16.5	Very tallowy

mercury-vapor lamp and sunlight for four hours under these wrappers.   In
general the development of peroxides was proportional to the ability of the
wrapper to transmit these short rays.

TABLE 3
The protective action of various wrappers

WRAPPER	SUNLIGHT 4½ HOURS		ULTRA-VIOLET LIGHT 15 MINUTES[3]		DIFFUSED DAYLIGHT 12½ HOURS		100 WATT LAMP 4 DAYS		INFRA-RED LAMP 14 HOURS	
	Flavor	Peroxide No.	Flavor	Peroxide No.	Flavor	Peroxide No.	Flavor	Peroxide No.	Flavor	Peroxide No.
Al. Foil	−	0.0	−	0.0	−	0.0	−	0.00	−	0.0
Green	−	0.14	−	0.0	−	0.00	−	0.05	−	0.0
Blue	−	0.29	+	0.0	?	0.29	?	0.32	−	0.0
Red	−	0.44	−	0.0	−	0.19	+−	0.49	−	0.0
Tango	+	0.78[5]	++	0.0	+−	0.57	+−	0.92	−	0.0
Pliofilm	++	0.79	++	0.0	+++	0.89	+++	0.97	−	
Pink	++	0.98	+++	0.0	+++	0.78	+++	1.27	−	0.10
Parchment	+	0.98	+++	0.0	+	0.86	++++	1.18	−	0.00
M.R.T.	+	1.01[4]	−	0.0	+++	0.79[4]	+	0.92[4]	−	0.23
M.A.T.	++	1.37	+−+	0.0	++−	0.88	+++	1.18	−	0.20
Glass	+++	1.96	+	0.0	++	1.47	[5]		−	0.0
Uncovered	++++	2.95	++++	0.0	++++	1.38	++−	1.48	−	0.0

The intensity of the tallowy flavor is expressed by the number of plus signs, a − sign designating that the tallowy flavor was not present.

1 Pliofilm melted into sample.
2 Purplish discoloration of tango cellophane.
3 Intensity: 760 microwatts/cm²/sec.
4 Pinkish discoloration of M.R.T. cellophane.
5 Sample lost.

In order to test the protective action of these wrappers when in contact with the butter, slices of butter one centimeter thick were cut from the end of a pound print, wrapped with one thickness of wrapper and exposed to light as designated in Table 3. With the exception of dark blue, the dark colored wrappers afforded the best protection for the butter as measured by the peroxide number and flavor. Although the effectiveness of the wrappers in preventing the development of tallowy flavor depended somewhat on the light source, the wrappers may be placed into three groups as follows:

GROUP I	GROUP II	GROUP III
Aluminum foil	Dark blue	Pink
Dark red	Tango	M.A.T.
Dark green	M.R.T	Pliofilm
	Parchment	Glass

The wrappers in Group I afforded very good protection for the butter, while those in Group II were less effective and those in Group III were the poorest.

Spectrographs (Figure 4) showed that the dark red and dark green
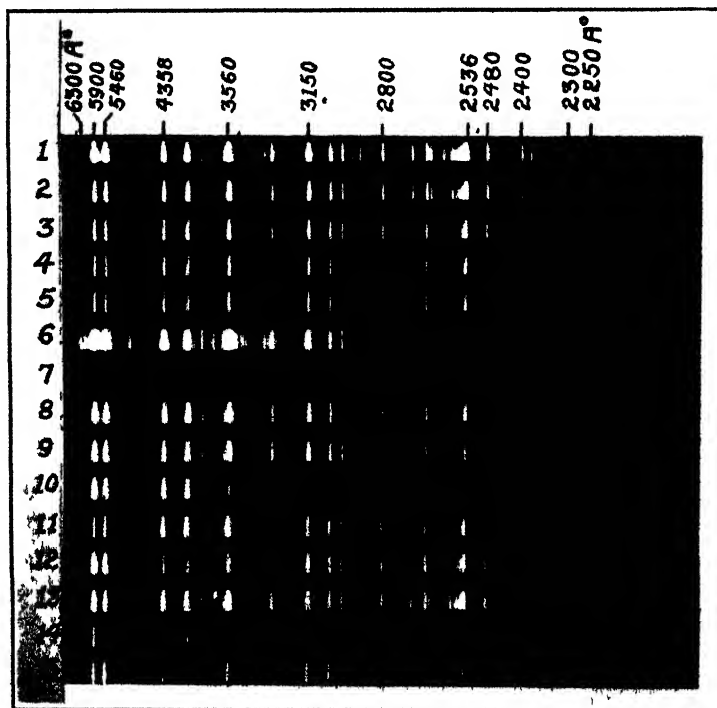
FIG. 4.   SPECTROGRAPHS OF VARIOUS TRANSPARENT WRAPPERS.

NUMBER	WRAPPER	EXPOSURE TIME	NUMBER	WRAPPER	EXPOSURE TIME
1	None	16 seconds	9	M.A.T.	16 seconds
2	"	8 "	10	M.R.T.	16 "
3	"	4 "	11	Dark blue	16 "
4	"	2 "	12	Tango	16 "
5	"	1 "	13	Pink	16 "
6	Petri dish cover	16 "	14	Dark red	16 "
7	Parchment	16 "	15	Dark green	16 "
8	Pliofilm	16 "			

wrappers listed in Group I transmitted radiations over a considerable range but with decreased intensity, especially in the ultra-violet.

The dark blue and tango cellophanes from Group II transmitted the radiations practically throughout the entire range, but with somewhat decreased intensity. The special light-filtering cellophane M.R.T. did not hinder the transmission of the longer wave-length rays but was very effective in screening out the ultra-violet rays. The spectrograph of the parchment showed very little transmission of light, yet this wrapper was not very effective in protecting the butter from oxidation when exposed to light. In further trials where the parchment was placed closer to the light source it was found that rays of wave lengths as short as 2480 Å was transmitted equally as well as the rays of longer wave lengths. However, due to the diffusion caused by the parchment the intensity of the transmitted light was greatly decreased.

The light rays passed through the pink and M.A.T. cellophanes and the pliofilm wrappers with very little hindrance. The glass Petri-dish cover screened out the radiations of shorter wave lengths and was more effective in preventing the oxidation of the butterfat than the other coverings listed in Group III.

The colors of the various transparent wrappers as measured by the Lovibond Tintometer (The British Drug Houses Pattern) are given in Table 4.

TABLE 4
Colors of the various transparent wrappers

WRAPPER	EXCESS BRIGHTNESS	COLOR IN LOVIBOND UNITS	
Dark green cellophane	3.2	6.7 green;	2.2 yellow
Dark red cellophane	3.1	20.1 red;	6.4 orange
Dark blue cellophane	3.4	11.1 blue;	0.4 green
Tango cellophane	0.9	13.4 yellow;	1.5 orange
Pink cellophane	1.0	2.0 red	
M.R.T. cellophane	0.1	0.2 violet	
M.A.T. cellophane		colorless	
Pliofilm		colorless	

These results definitely show that a tallowy flavor will develop in butter-fat as a result of oxidation by air and heat in the absence of light. The presence of light, however, greatly hastens the development of a tallowy flavor. The tallowy flavor does not appear at any definite peroxide value but seems to vary with the different samples of butterfat. However, a positive peroxide test was always obtained before a tallowy flavor was evident, except when butter had been exposed to the quartz mercury-vapor lamp. Fresh butterfat contains no peroxides.

When the wrappers were placed in contact with the butter the dark green wrapper was the most effective of the transparent wrappers in preventing the oxidation of the butterfat, but when butteroil was used and the wrapper was not in contact with the fat, the dark red wrapper was somewhat more effective than the dark green. The M.R.T. cellophane was not as effective when in contact with the butter as it was when it did not touch the butter. This was due, no doubt, to the pink discoloration of this cellophane when exposed to light and in contact with the butter. It was found that neither the fat nor the salt affected the discoloration, but that it was due to moisture in the presence of air. When air was excluded, the sun and water did not cause discoloration.

It appears from the data that all sources of visible and ultra-violet light are effective in catalyzing the oxidation of butterfat. It is evident that ultra-violet radiations are more effective than radiations of greater wave length and that the speed of oxidation is influenced by the intensity of the light. Due to the low intensity obtainable from a monochromator, no attempt was made to determine if any specific ray was more effective than others except as the various wrappers transmitted more light in one zone than in another.

SUMMARY

The end of the induction period during the oxidation of butterfat in the absence of light is well marked by a rapid bleaching of the color and a rapid increase in peroxides, followed by an increase in volatile acids.

The development of peroxides ordinarily precedes the appearance of a tallowy flavor but the tallowy flavor is not always apparent at the same peroxide number.

Light, especially ultra-violet light, exerts a marked catalytic effect on the oxidation of butterfat.

Aluminum foil wrappers, which excluded the light entirely, prevented the oxidation of the butterfat. Of the colored transparent wrappers dark green and dark red were the most effective.

To protect butter from the catalytic effect of light a transparent wrapper

should exclude at least the ultra-violet light and decrease the transmission of the longer rays as much as possible.

The authors wish to express their thanks to Professor L. C. Thomsen for the help given in judging the flavor of the butter samples.

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A SIMPLE METHOD FOR THE DETECTION OF COPPER IN ALLOYS

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Many alloys in use today contain large amounts of copper. In the case of brass and bronze, this fact is readily recognized. In the case of other alloys, such as nickel silver or monel metal, the presence of copper is not so obvious. Few, for instance, would suspect that a five cent piece contains 75 per cent of copper.

Since these copper alloys injure the flavor of milk to almost the same extent as pure copper, a simple method is needed for their detection. The following test was devised for use by the extension service of this department, and it has aroused so much interest that the details are published here. The method is based upon the fact that copper chloride imparts characteristic blue and green colors to a non-luminous flame. It is true that thallium and tellurium also yield green flames, and that arsenic lead and selenium may yield blue flames, but the characteristic colors due to copper may be readily recognized by one who is not color blind. Furthermore, with the exception of lead which is used in solder, it is quite unlikely that those elements which might cause confusion would ever be found in dairy equipment.

First, prepare test paper by placing a clean sheet of fine sandpaper, rough side down, upon a sheet of glass or paper. Then saturate the back of the paper with a solution of 10 grams of pure ammonium chloride in 30 ml. of water. This may be applied quite easily by means of a cotton swab. After the paper is well saturated, it should be hung up to dry and then cut into strips approximately two inches long and one-third inch wide. These can be stored in a wide-mouthed bottle and, if kept clean, should keep almost indefinitely.

In order to make the test, one end of a strip is rubbed over the metal until a dark smudge appears on the rough paper. This smudge should be at the extreme end of the paper. If it is not, tear off the clean paper projecting beyond the smudge. Then place the *tip* of the paper strip in the outer edge of a non-luminous bunsen flame, or in the flame of an alcohol lamp. The paper should be held near the base of the flame. At first, as the paper burns, the flame will be colored yellow. Then, when the yellow disappears, the flame next to the charred end of the paper will be tinged azure blue if copper is present. This blue changes to green if the paper is withdrawn from the flame slightly and then the blue color can be restored by heating again more

A test of a simple method for the detection of copper alloys

SAMPLE NUMBER	RESULT	CHARACTER OF SAMPLE
2101	Negative	Aluminum, hard English
2106	Negative	Aluminum, hard English
2005	Negative	Aluminum, soft English
2001	Negative	Aluminum, soft English
601	Positive	Nickel silver (72% copper)
1402	Negative	Aluminum
701	Positive	Monel metal (28% copper)
1401	Negative	Aluminum
4010	Negative	Allegheny metal
4011	Negative	Allegheny metal
1601	Negative	Allegheny metal
A	Negative	Pure aluminum
501	Negative	Enduro A
502	Negative	Enduro A
B	Negative	Pure tin
C	Negative	Antimony
D	Negative	Lead
5	Negative	Aluminum
9	Positive	Brass (63% copper)
602	Positive	Nickel silver (60% copper)
1503	Positive	Nickel silver (72% copper)
1501	Positive	Nickel silver (72% copper)
401	Negative	Nickel
402	Negative	Nickel
8	Positive	Ambrac (75% copper)
1101	Negative	Nickel
201	Positive	Monel metal (28% copper)
202	Positive	Monel metal (28% copper)
705	Positive	Monel metal (28% copper)
301	Positive	Pure copper
302	Positive	Pure copper
E	Negative	Solder

strongly.   In case of doubt, the paper can be reversed, and the clean end used as a control for comparison.

Before using the test on unknown alloys, the operator should try it on a sample of brass or copper in order to become familiar with the colors.   There is also a possibility that samples of sandpaper might be found which contained copper when purchased.   Such samples have never been encountered here, but it is advisable to be sure that the paper gives a satisfactory blank before it is used on unknown samples.

As a test of this method in the hands of an amateur, a student was instructed to prepare some test paper according to these directions and test a series of metals and alloys.   The composition of these samples was unknown to the student but examination of the table below shows that he did not make a single error.

THE RELIABILITY OF SELECTED TESTS FOR THE DETECTION OF MASTITIS

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Various investigators, notably Cherrington *et al.* (1), Halverson *et al.* (2), Horrall (4), Hucker (5), and Jacobsen (8), have reported that no one of the different tests used for the detection of mastitis is sufficiently reliable to determine all cases of chronic mastitis. Unfortunately, however, the respective investigators differ in their opinion as to the most reliable test to use.

Unpublished work done at the Idaho Agricultural Experiment Station has demonstrated conclusively that it is sometimes impossible to isolate streptococci from fresh milk drawn from cows known to have mastitis. The work herein reported was inaugurated because of the conflicting opinions expressed in the literature as to the relative merits of the different tests for mastitis. The work was undertaken to determine the relative accuracy and reliability of some of the more common tests for mastitis on milk from cows having acute mastitis, mild chronic mastitis, and no detectable udder infection.

METHODS

Ten cows were selected from the University of Idaho dairy herd for study. Five cows, numbers 67, 61X, 29X, 189, and 8X, were selected because they were giving milk abnormal in appearance and had suffered from swollen quarters at frequent intervals. In addition, these cows had reacted positively in all milking quarters to two or more of the common tests for mastitis run at intervals of six months during the past four years.

Two cows, 187 and 28X, were selected after preliminary tests had shown that the causal organisms were eliminated in the milk at irregular intervals from all four quarters.

Three cows, 102X, 101X, and 199, were two-year-old heifers, milking their first lactation, and were, when selected, definitely negative in all quarters, as shown by the tests for chlorides, hemolytic organisms, streptococci, leucocytes, and hydrogen-ion concentration.

Before collecting the samples from the quarters, the lower part of the udder and the teats were thoroughly washed with a sterilizing solution, containing 500 parts per million of available chlorine. Particular attention was given that the ends of the teats came in contact with the sterilizing solution.

TABLE 1

The reliability of selected tests for the detection of mastitis

NO. OF COWS	NO. OF SAMPLES	INCUBATED AT 37°C 12 HOURS FOR CAUSAL ORGANISM		HEMOLYTIC ORGANISM PRESENT		CELLS 100,000 PER CC INDICATE MASTITIS		CHLORIDES OVER 0.16% MASTITIS		HYDROGEN ION CONCENTRATION OVER 6.8 MASTITIS		CAUSAL ORGANISM
		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	
						Positive Mastitis (Abnormal Milk)						
67	56	56	0	56	0	56	0	56	0	56	0	Streptococcus
29X	56	52	4	48	8	52	4	56	0	37	19	Streptococcus
8X	43	39	3	34	8	34	8	15	27	1	41	Streptococcus
61X	56	55	1	51	5	44	12	0	56	5	51	Streptococcus
189	42	31	11	19	23	30	12	4	38	6	36	Streptococcus
Total	252	233	19	208	44	216	36	131	121	105	147	
Per cent		92.5	7.5	82.5	17.5	85.7	14.3	51.9	49.1	41.7	58.3	
						Mild Chronic Mastitis						
56X	56	32	24	25	31	16	40	0	56	0	56	Streptococcus
187	56	9	47	3	43	15	41	0	56	0	56	Streptococcus
Total	112	41	71	28	84	31	81	0	112	0	112	
Per cent		36.6	63.4	25.0	75.0	27.7	72.3		100		100	
						Negative Mastitis						
101X	56	6	50	3	53	1	55	0	56	0	56	No infection
102X	42	2	40	0	42	0	42	0	42	0	42	No infection
199	56	3	53	0	56	8	48	0	56	0	56	No infection
Total	154	11	143	3	151	9	145	0	154	0	154	
Per cent		7.1	92.9	1.9	98.1	5.8	94.2		100		100	

After discarding the first four streams of milk, separate samples of 80 cc. were taken from each teat into a sterile, cotton-stoppered 120 cc. test tube.

The following tests were made on all the milk samples:

1. The presence of streptococci after the milk samples had been incubated for twelve hours.

2. The presence of hemolytic bacteria by plating the milk on beef infusion agar to which was added 1 per cent dextrose and not less than 5 per cent defibrinated blood.

3. Cell count (leucocytes).

4. Per cent chlorides.

5. Hydrogen-ion concentration.

<div align="center">RESULTS</div>

Results of the various tests are presented in Table 1 and is a summary of the examination of 518 samples of milk taken from the ten cows over a 14-day period.

The data presented show that of the 252 samples of milk from cows definitely having mastitis in all milking quarters, both at the beginning of the 14-day period and at the end of the 14-day period, the presence of streptococci in incubated samples of the milk was demonstrated in 233 or 92.5 per cent of the samples. When used on the milk of cows having mild chronic mastitis, the test demonstrated the presence of streptococci in only 41 out of 112 samples, or only 36.6 per cent of the total. Streptococci were found in 11 samples out of 154, or 7.1 per cent of the total, when the milk was from cows definitely possessing no mastitis in any of the milking quarters, either at the beginning or end of the 14-day test period. The data indicate that the test for streptococci in samples of the milk incubated at 37° C. for 12 hours is a very accurate test for acute mastitis, but gives somewhat unreliable results when the disease is of a mild although chronic nature.

One of the most widely used methods for detecting cows harboring udder infections is the blood agar technique. The value of this test has been studied by various investigators, particularly Plastridge et al. (10), Cherrington et al. (1), and Hucker et al. (7). Hucker et al. (7) found that veal infusion horse-blood agar plates reveal less than 40 per cent of the udders which discharge streptococci. The data in Table 1 show that in the work herein reported the blood agar plates showed hemolytic areas in 82.5 per cent of the milk samples obtained from cows secreting milk abnormal in appearance, in 25 per cent of the milk samples taken from chronic cases of mastitis, and in 1.9 per cent of the samples from negative cows.

According to Hucker (5), 90 per cent of the normal udders free from scar tissue show less than 60,000 leucocytes per cc. of milk. Hucker and Udall (6) reported that udders free from induration or scar tissue are free from demonstrable streptococci, do not show cells in excess of 500,000 per cc.

Cherrington *et al.* (1) found that normal udders usually contain less than 50,000 cells per cc., whereas milk from infected udders invariably contains more than 100,000 per cc. In the present study any samples showing a cell count in excess of 100,000 per cc. was considered to come from an infected udder. On this basis, as shown in Table 1, the cell count of 85.7 per cent or 216 of the 252 samples taken from the positive cows contained cells in excess of 100,000 per cc., while only 27.7 per cent or 31 of the 112 samples taken from the chronic mastitis cases and 5.8 per cent or 9 of the 154 samples taken from the negative cases were in excess of 100,000 per cc.

Hucker *et al.* (7) found that normal milk varied from 0.09 to 0.14 per cent chlorides, and that a chloride content in excess of 0.16 per cent could be used in detecting chronic cases of mastitis. Hayden (3) also found a close correlation between the chloride test and other more complicated methods. Table 1 shows that of the 252 samples of milk taken from positive cows 131 or 51.9 per cent contained chlorides in excess of 0.16 per cent, while all samples taken from cows with mild chronic mastitis and negative cows contained less than 0.16 per cent chlorides.

Hucker *et al.* (7), Hucker and Udall (6), Rosell (11), Horrall (4), and Proudy (9) have shown that a change in reaction of milk toward a neutral or slightly alkaline reaction to be a very sensitive test for detecting milk which was abnormal to other tests. If a hydrogen-ion concentration above pH 6.8 is indicative of mastitis, this test was only 41.7 per cent accurate on samples of milk taken from cows secreting milk abnormal in appearance. None of the samples of milk taken from cows infected with chronic mastitis and none of the samples taken from cows free from mastitis had a pH above 6.8.

CONCLUSIONS

The results of an examination of 518 samples of milk taken from 10 cows over a 14-day period, using tests to demonstrate the presence of streptococci in incubated samples, hemolytic bacteria, cell count, chloride content, and hydrogen-ion concentration demonstrated the following:

(1) The presence of streptococci in 92.5 per cent of the samples taken from cows giving abnormal milk, 36.6 per cent of the samples taken from cows having mild chronic mastitis, and 7.1 per cent of the samples taken from cows definitely free from mastitis.

(2) The presence of hemolytic bacteria in 82.5 per cent of the samples obtained from cows secreting milk abnormal in appearance, 25 per cent of the milk samples from cows having mild chronic mastitis, and 1.9 per cent of the samples taken from definitely negative cows.

(3) The presence of cell in excess of 100,000 per cc. in 87.7 per cent of the samples taken from cows secreting abnormal milk, 27.7 per cent of the samples taken from mild chronic mastitis, and 5.8 per cent of the samples taken from negative cases.

(4) The tests using the percentage of chlorides and hydrogen-ion concentration were extremely unreliable in detecting cows suffering from chronic mastitis.

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STREPTOCOCCUS CREMORIS

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According to Orla-Jensen (1), to Storch belongs the credit for having first observed that the best lactic acid streptococci for "starter" use have more tendency to form chains and to produce a slightly viscid or slimy body in milk cultures, than does the typical *Streptococcus lactis* of sour milk. Such an ill-defined type has long been known as a variety of *S. lactis* and also under the specific name of *S. hollandicus*. To our own personal knowledge, many of the more successful commercial starters used in America during the past twenty-five years have contained chain-forming organisms of this group.

However, it is Orla-Jensen (1) who has studied and described more fully the type of streptococcus supposedly superior for starter purposes, and he has given this organism the name of *Streptococcus cremoris*. He showed that this organism is usually a more typical chain-forming streptococcus than is *S. lactis*; frequently fails to grow at 37° C.; usually produces less acid in milk; and in general has less fermentative power than does *S. lactis*, especially on maltose and dextrin. Anna Orla-Jensen and Hansen (2) differentiated *S. cremoris* from *S. lactis* on the basis of the fermentation reactions, the former failing to ferment maltose and dextrin while the latter fermented these substances "to a smaller or larger extent."

It is clear, therefore, that although the splendid work of Orla-Jensen and his associates indicates that *S. cremoris*, as now known, is a rather distinct type of lactic acid streptococcus, the species has not been so clearly defined as is necessary. The differences between *S. cremoris* and *S. lactis* appear to be relative or quantitative ones rather than definitive. This appears to be true of the fermentation tests with maltose and dextrin, a number of the strains of *S. cremoris* attacking these substances at least weakly (1, 2). Dextrin, it seems to us, is too lacking in known chemical identity to be reliable for a species differential test, and work done in this laboratory (3) has thrown serious doubt upon the value of maltose in the identification of *S. cremoris*.

Before work was begun on this problem, the thought occurred to us that perhaps the *S. lactis* var. B, described by Ayers, Johnson and Mudge (4), was in fact the same as Orla-Jensen's *S. cremoris*. The outstanding feature of the "B" variety of *S. lactis* was its inability to produce ammonia from peptone, while the typical *S. lactis* is able to produce this substance in 4 per cent peptone solutions (4, 5). Other less sharply defined characteristics of *S. lactis* var. B were a higher average limiting pH in glucose broth than has

S. lactis, and a tendency to be inhibited by methylene blue, a substance to which the lactic streptococci show a rather marked tolerance (6).

Even if the valuable works of Orla-Jensen and of Ayers and his associates could be brought together, it is clear that other more incisive reactions are needed to correlate with the ammonia test in order to establish *S. cremoris* more clearly as a species. This we appear to have accomplished by applying the same tests, *at different levels,* that were used by Sherman and Stark (7) for the differentiation of *S. lactis* from *S. fecalis.*

Of the 41 cultures which were identified as *S. cremoris* in this study, 31 were isolated from commercial starters; eight were isolated from raw milk; two were cultures of *S. cremoris,* one from the laboratory of Dr. Orla-Jensen and one from Dr. Kluyver. These two cultures were kindly furnished to us by Dr. G. J. Hucker.

For comparison, 25 cultures of *S. lactis* were used. Of these, 19 were isolated from commercial starters. Five of the cultures were from sour milk and were isolated and added to the collection because, from morphological appearance, it was thought that they might prove to be *S. cremoris.* The other three cultures came from foreign investigators who had isolated them from starters and considered them to be *S. cremoris,* but they proved to be *S. lactis* as judged by the criteria used by us. We feel that the fact that the *S. lactis* cultures used came principally from starters, rather than being recent isolations from milk, gives more weight to the differential tests employed, since the majority of the strains of each species represented had much the same history from the standpoint of previous artificial cultivation.

All of the cultures used, of both species, satisfied the basic criteria for members of the "lactic group" of streptococci, in that they grew at 10° C., did not grow at 45° C., and reduced litmus in milk before curdling.

METHODS

As most of the methods used are well-known procedures in the study of streptococci, mention will be made only of those not in more general use. In all tests used except those which had to do with temperature limits of growth, the cultures were incubated at 30° C. and incubation was continued for one week unless the positive results revealed by the tests were evident in less time. In the experiments involving ammonia production, total acidity, final pH, and acetyl-methyl-carbinol production, the cultures were all incubated for one week at 30° C.

Ammonia production was determined in 4 per cent peptone (Difco) under three different conditions: (1) peptone only; (2) meat infusion plus peptone; and, (3) cabbage infusion plus peptone.

Media in which cabbage was used contained the infusion from 100 grams of fresh cabbage in a liter of medium. The cabbage was finely cut in a food

chopper, water added, heated for ten minues at 100° C., filtered, and the extract so obtained added to the other ingredients.

Salt tolerance tests were conducted in a basic medium which contained, per liter: infusion from 100 grams of cabbage, 10 grams of tryptone (Difco), 5 grams of sodium chloride, 2.5 grams of dibasic sodium phosphate, and 1 gram of glucose. Additional sodium chloride was then added to this medium to give the desired concentration. In running the tests, the cultures were first grown in the basic medium and then transferred to those containing the various salt concentrations. At the same time, the cultures were transferred again to the basic medium to serve as controls on the viability and growth of the organisms.

For determining the alkaline limits of growth, nutrient broth was adjusted to the desired pH and autoclaved. To the sterilized broth was added sufficient sterile glucose solution to give a concentration of 0.5 per cent. The reaction of the finished broth was of course checked as used.

Methylene blue tolerance was determined in skimmed milk. The proper amount of medicinal methylene blue was placed in a flask, moistened with distilled water, and autoclaved. To this was added the correct amount of sterile skimmed milk, mixed, allowed to stand for several hours, again thoroughly mixed, and tubed aseptically.

Acetyl-methyl-carbinol, including diacetyl, was determined quantitatively by the method of van Niel (8) on 200 grams of each culture in skimmed milk. As the analyses were made after an incubation period of one week at 30° C., the possibility should be recognized that some of the negative cultures might have given evidence of the substance had the tests been made earlier.

THE IDENTITY OF STREPTOTOCCUS CREMORIS AND ITS DIFFERENTIATION FROM STREPTOCOCCUS LACTIS

With respect to morphology, our findings agree with those of previous workers in that *Streptococcus cremoris*, as a rule, is a more typical chain-forming streptococcus than is *S. lactis*. However, some of our strains occurred more typically as diplococci in milk cultures. On the other hand, some of the strains of *S. lactis* also produced chains, a fact which has of course long been known. Also, in many cases the cells of *S. cremoris* are distinctly larger than those of *S. lactis*, but there are so many exceptions to this rule that it cannot be relied upon in the case of any individual culture. So far as our limited experience goes, however, those cultures which were characterized both by large cells and by the formation of long chains in milk cultures proved to be *S. cremoris*.

It is apparent that morphology and cell arrangement cannot be relied upon alone in the identification of *S. cremoris*. As a matter of fact, it has long been known that *S. lactis* characteristically forms long chains under

some conditions. More than thirty years ago, Heinemann (9) showed that *S. lactis* grows as a typical chain-forming streptococcus in blood serum broth, and somewhat later Sherman and Albus (6) found the same to be true in a bile medium. Both of these facts concerning chain formation have been confirmed by Hucker (10); and doubtless many other conditions of growth induce chain formation.

In Table 1 are given the characteristics which we have found useful in differentiating *S. cremoris* from *S. lactis*. Included in the table are not only the four tests which have thus far proved of definite value for this purpose, but also those which have some supporting value in showing relative differences.

TABLE 1

The differentiation of Streptococcus cremoris from Streptococcus lactis

SPECIES	NUMBER OF CUL-TURES STUDIED	AMMONIA PRODUCED IN 4 PER CENT PEPTONE	GROWTH AT 40° C (IN LITMUS MILK)	GROWTH IN BROTH WITH 4 PER CENT NACL	GROWTH IN BROTH WITH PH 9 2	GROWTH IN METHYLENE BLUE (0 3%) IN MILK	GROWTH AT 37° C (IN LITMUS MILK)	ACETYL METHYL-CARBINOL PRODUCED IN MILK	FINAL PH IN GLU-COSE BROTH LOWER THAN 4.3	FERMENTATION OF MALTOSE
S. lactis	25	+	+	+	+		+	6+ 19−	24+ 1−	+
S. cremoris	41	−	−	−	• −	13+ 28−	15+ 26−	26+ 15−	14+ 27−	25+ 16−

A few words are in order in connection with the test for ammonia production. Of the 41 cultures of *S. cremoris* used, none was able to produce ammonia in 4 per cent peptone without other nutrients. In the cabbage infusion medium one culture gave a positive reaction, while in the beef infusion medium eight cultures gave faint tests for ammonia. As most of the cultures of *S. cremoris* were unable to produce visible growth in the peptone solution alone, this test could be criticised, on philosophical grounds at least, as not being, in some cases, a test for ammonia production *per se*. This objection, however, need not detract from the usefulness of the test as a practical method in the differentiation of the two species.

Concerning the ability of *S. lactis* to produce ammonia in 4 per cent peptone, to grow at 40° C., and to grow in the presence of 4 per cent sodium chloride, we have verified these facts on a large number of cultures in addition to those used in this comparison. With reference to the ability of *S. lactis* to grow in broth with an initial pH of 9.2, we have checked this characteristic on only a few strains in addition to the 25 used in this study, and hence we advance this test with some reservation.

As concentrations of methylene blue greater than 0.3 per cent cause milk to curdle, larger amounts of this substance were not tested. If it is desired

to obtain additional tests for the differentiation of *S. cremoris* from *S. lactis*, it is quite possible that this could be done on the basis of tolerance to methylene blue in a medium other than milk. The other less perfect tests given in Table 1 confirm the relative tendencies observed by previous workers (1, 2, 4, 11).

In Table 2 are given the additional properties of *S. cremoris* needed for a more complete characterization of the species.

It is not necessary to discuss the additional characteristics of *S. cremoris* other than to call attention to the fact that the fermentation tests show rather wide variation within this species, as is true of the streptococci generally. About all that can be said of these tests is that, so far as this small collection reveals, the hexose sugars and lactose are in general fermented, while the pentose sugars, inulin and glycerol are not. The other test substances may or may not be fermented. It is quite probable that a larger collection of cultures would show additional variations, especially with the pentose sugars and lactose on which previous work indicates some variation within this and related species (1, 2, 12).

General Characteristics

Chain formation is fairly characteristic though some strains occur more typically as diplococci. Although *Streptococcus cremoris* on the average is characterized by the production of longer chains and larger cells than *S. lactis*, positive differentiation cannot now be based on morphology.

Blood is not hemolyzed; gelatin is not liquefied; milk is acidulated and curdled, without visible evidence of digestion of the casein; in glucose broth, final pH values of 4.6 to 4.0 are attained. Neither sodium hippurate nor starch is hydrolyzed, while esculin may or may not be attacked. In skimmed milk cultures, acetyl-methyl-carbinol may or may not be present, but appears to be more frequently produced.

Important Differential Characteristics

Growth occurs at 10° C. but not at 40° C.; growth may or may not take place at 37° C. Litmus in milk cultures is completely reduced below the surface layer, the reduction taking place prior to the curdling of the milk. Ammonia is not produced in 4 per cent peptone; there is no growth in broth containing 4 per cent sodium chloride; growth is not initiated in alkaline broth having a pH of 9.2. *S. cremoris* has a rather marked tolerance to methylene blue, but growth is usually inhibited in the presence of 0.3 per cent of this substance in skimmed milk.

Fermentation Reactions

Streptococcus cremoris varies rather widely on the fermentation tests. Glucose and lactose are fermented; arabinose, xylose, inulin, and glycerol

TABLE 2

Other characteristics of Streptococcus cremoris

| | ACID PRODUCED IN BROTH CONTAINING | | | | | | | | | | | HYDROLYSIS OF | | | LIQUEFACTION OF GELATIN | TRUE HEMOLYSIS OF BLOOD | FINAL pH IN GLUCOSE BROTH | TOTAL ACIDITY IN MILK AS LACTIC ACID (%) | REDUCTION OF LITMUS MILK BEFORE CURDLING | GROWTH AT 10° C. |
	Arabinose	Xylose	Glucose	Lactose	Maltose	Sucrose	Raffinose	Inulin	Salicin	Glycerol	Mannitol	Sodium hippurate	Starch	Esculin						
	−	−	+	+	25 + 16 −	8 + 33 −	4 + 37 −	−	20 + 21 −	− ·	1 + 40 −	−	−	25 + 16 −	−	−	4.6 to 4.0	0.45 to 0.85	+	+

are not fermented; maltose, sucrose, raffinose, mannitol, and salicin may or may not be fermented, although sucrose, raffinose, and mannitol are usually not attacked.

DISCUSSION

Based upon present practices in the classification of bacteria, there would appear to be little doubt that the type which is here designated as *Streptococcus cremoris* is entitled to separate rank as a species apart from *S. lactis*. The differentiation appears to be clear and to be based upon physiological characteristics of a rather basic nature. It seems, also, that the species as we have defined it brings together the *S. cremoris* of Orla-Jensen and the important though little known *S. lactis* var. B of Ayers, Johnson and Mudge, and indicates the identity of these previously described types. It is true that the criteria used by us in the differentiation of this organism cut rather rudely through some lines which have heretofore been used to mark the limits of the species. Their validity or invalidity can be established only through further work on the part of bacteriologists in various laboratories.

Also important as evidence of the integrity of *S. cremoris* as a species is the fact that eight of our cultures were isolated from raw milk and hence could not be looked upon as representing only adaptive forms brought about through long cultivation under special conditions. This was also true of a number of the cultures which were identified by Orla-Jensen and Hansen (2) as *S. cremoris*.

We have done no work upon the application of *S. cremoris* and *S. lactis* for commercial purposes, and hence will refrain from commenting to any extent on this subject. Orla-Jensen's work would appear to establish the general superiority of *S. cremoris* in the butter industry. However, it may be noted that some of the excellent commercial starters examined by us contained *S. lactis* and not *S. cremoris*. Although *S. cremoris* appears to produce acetyl-methyl-carbinol more frequently and usually in larger amounts, than does *S. lactis*, it so happened that the individual culture, among those studied by us, which produced the largest amount of this substance was a strain of *S. lactis*. From the standpoint of acetyl-methyl-carbinol and diacetyl, it should also be remembered that these substances are produced in much greater amounts by the aroma-producing organisms of the *Leuconostoc* group which are commonly also present in commercial starters.

For cheesemaking, quite another point becomes obvious: The low tolerance of *S. cremoris* for salt throws some doubt upon its efficacy as a culture for many types, and the experimental work of Kelly (13) on cheddar cheese lends some weight to this suspicion. With a number of simple tests to separate more clearly these two important species of lactic acid streptococci, additional work on the practical applications of the organisms might prove fruitful.

Some of those interested in bacteriological nomenclature might argue, with some reason, that an older name, such as *S. hollandicus,* should be used for this species. We think that the name applied by Orla-Jensen, *S. cremoris,* should stand. However desirable, from the standpoint of less confusion in the literature, it might have been to use a prior name, since he chose to use a new one it should be accepted, as Orla-Jensen was the first to describe this type with sufficient clarity so that it could be recognized, in some cases at least, by other workers.

SUMMARY

A more extended description of *Streptococcus cremoris* than heretofore available is presented, and the validity of this type as an independent species is indicated. In addition to a number of tests which show relative differences between these two species, some new characteristics are suggested which appear clearly to differentiate *S. cremoris* from *S. lactis.*

Specifically, *S. cremoris* may be separated from *S. lactis* by the inability of the former to produce ammonia in 4 per cent peptone, and its inability to grow: at 40° C., in the presence of 4 per cent sodium chloride, and in alkaline broth with a pH of 9.2. *S. cremoris* is also usually less tolerant to methylene blué than is *S. lactis.*

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A STUDY OF OXIDIZED FLAVOR IN COMMERCIAL PASTEURIZED MILK

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The group of off flavors found in raw and pasteurized milk which are known by the terms papery, cappy, cardboard, tallowy, etc., have been the subject of much research and discussion in the past decade. It is generally assumed that these off flavors are due to oxidation of one or more constituents of the milk. They are collectively described as oxidized flavor. The attention of scientific investigators has been directed to establishing the causes of this flavor defect and the suggestion of practical remedies. Among the factors which are generally believed to influence the development of oxidized flavor in milk are feed of the cow; the amount of natural anti-oxidants; enzyme activity; dissolved oxygen; the oxidation-reduction potential; bacterial activity; dissolved copper; and exposure to sunlight. These factors and probably others acting singly or collectively bring about changes in milk which are detected by tasting as oxidized flavor.

Relatively few flavor complaints are received from customers of plants which distribute milk having oxidized flavor more or less regularly in the winter months. Because of this fact pasteurized milk distributers are inclined to minimize the importance of this flavor defect and point out that expert "tasters" are more critical of milk flavor than their customers. Nevertheless, oxidized flavor is a problem to those milk distributers who are so unfortunate as to find it present in their products.

Despite the fact that considerable research has been conducted on the causes of this flavor, relatively little has been published on the frequency with which oxidized flavored milk is encountered under commercial conditions. Trout (1) reported a study of 290 samples of commercial milk scored by 6 experienced judges. Forty-five or 15.5 per cent were classified as having an oxidized flavor.

PROCEDURE

In order to study the frequency of the oxidized flavor defect in commercial market milk an examination was made of various grades of pasteurized milk sold in 16 cities by 19 different dairies. These cities were located in New England, along the Atlantic Seaboard to Washington, and west to Milwaukee. Pasteurized milk only was examined, both standard or regular grade and so-called premium grade, which commands a higher price. No milk of the certified grade was studied. Samples were collected over a 5-month period during the winter of 1935–1936. In addition to the flavor

TABLE 1

The grade, fat content, flavor, and bacteria counts of 139 samples of commercial pasteurized milk taken over a period of five months in 1935–36

MILK COM- PANY NO.	GRADE OF MILK	AVER- AGE FAT CON- TENT (%)	FLAVOR[1]					DIRECT MICROSCOPIC COUNT (PER CC)[2]					PLATE COLONY COUNT (PER CC)				
			Nov	Dec	Jan	Feb	Mar	Nov	Dec	Jan	Feb	Mar	Nov	Dec	Jan	Feb	Mar
1	A	4.3	0	0–	0–	0	X–	714	336	588	336	210	900	200	3,300	330	200
1	A*	5.1	0	0	X–	X–	X+	–	588	336	546	168	–	200	510	310	100
2	A*	4.5	–	0	–	–	0	252	420	–	–	126	500	200	–	–	800
2	B	3.6	0	0	–	–	0	168	966	–	–	420	1,100	400	–	–	900
3	A*	4.5	X	X–	0	0	0	168	1,638	–	–	504	700	1,200	–	–	200
3	B	3.9	X	0	–	0	0	42	882	–	–	756	1,000	300	–	–	1,250
4	A*	4.5	X+	X++	X	0–	0–	42	588	714	252	84	700	300	3,000	460	550
4	B	3.8	X+	0–	0–	0–	0–	42	1,134	798	336	42	800	100	320	320	200
5	B*	4.0	–	–	–	–	–	<42	–	–	–	3,108	–	–	–	–	9,600
6	A*	4.7	X+	0	0	0	0	462	588	1,512	756	798	<100	1,300	5,600	1,800	3,100
7	A*	4.1	0	0	0–	0–	0	84	1,176	966	420	1,050	600	3,100	10,500	4,100	16,200
7	B	3.8	0	X–	0–	0–	0	924	756	588	294	84	1,800	1,300	390	1,410	150
8	A*	4.0	0	0	0–	0–	0	168	714	672	378	504	1,000	1,300	3,100	10,800	5,550
8	B	3.9	0	0	0–	0–	0	126	420	504	378	924	900	600	1,320	3,960	10,600
9	A*	4.3	0	0	0–	0–	0	168	504	1,470	2,194	294	400	1,800	1,700	3,160	4,650
9	B	3.7	0	0	0–	0–	0	588	378	504	462	966	2,600	3,300	4,700	2,400	1,300
10	A*	4.4	0	0	0–	0–	0	<42	–	546	126	336	3,300	–	1,900	2,680	1,150
10	B	3.8	X	0	0	X–	0–	462	630	630	294	336	2,200	300	460	140	500
11	A	4.4	0	0	0	X–	0	42	630	672	378	1,512	300	200	150	110	100
11	A*	4.9	0	0	0	X+	0	94	504	336	126	168	400	300	540	190	–
12	A*	4.8	X++	X–	X+	X+	0–	168	714	588	420	–	900	300	3,500	1,180	–
13	B	4.0	0–	0	0	0–	0–	420	672	1,218	504	882	2,300	1,000	17,100	3,240	8,000
13	A*	4.8	0–	0	0	0–	0–	2,016	1,512	1,344	1,260	1,260	600	600	32,200	17,200	30,000
14	B	3.6	0	0	0	0–	X	2,940		1,092	714	504	9,300	4,200	1,900	3,600	5,500
15	A*	4.9	0	0	X	0–	0–	2,310		672	630	1,050	4,500	–	5,800	5,100	25,700
15	B	3.7	X+	X	0	0	0	3,444	1,260				11,900	1,100			
16	A*	4.8	X	0	0	–	–	2,436	336		1,890		6,800	300	3,840	6,800	4,500
16	B	3.8	0	0	0–	X	X	2,268	168	294	588	714	1,600	2,900	8,700	2,400	–
17	A*	4.2	0	–	–	–	–	1,890		1,428	756		5,100		14,720	600	–
17	A*	4.4	0	0	–	–	–	1,302		1,302			15,700		31,200		–
18	A*	4.1	–	0–	0	0–	X+	462	7,996	10,940	6,132	1,764	4,900	39,000		6,100	800
18	B*	4.1	–	X	X–	0–	0–	–	10,332		13,104	2,856	–	45,000		3,700	600
19	B*	4.0	–	0	X–	X–	X–	–	588	2,604	714	630	–	210	470	420	500
19	B*	5.1	–	0	0	0	0	–	1,596	2,220	4,200	1,218	–	130	430	360	1,900

* Denotes Milk of Premium Grade.

[1] Key to Flavor:
0 = O.K., good.
0– = Slight off flavor.
X– = Slight oxidized flavor.
X = Oxidized flavor.
X+ = Strong oxidized flavor
X++ = Very strong oxidized flavor
– = No sample.

[2] 000 omitted.

a record was made of the grade, the fat content, and the bacteriological quality of the milk. On the first Monday of November and December, 1935, and January, February, and March, 1936, quart samples of each grade of milk were taken from the bottle fillers during the middle of the run and shipped in well-iced containers to this laboratory by express. Improperly refrigerated samples were discarded. The samples were held in a refrigerator at 40° F. in the original bottle until the storage period after bottling totaled 48 hours. At that time the bottles were opened aseptically and samples for bacteriological analysis were taken. Bacteriological samples were plated immediately on standard nutrient agar and the plates incubated at 98° F. for 48 hours. Smears were also made for direct microscopic examination and stained according to standard methods (2). A sample was tested for butterfat by the Babcock method. The milk was then warmed to 80° to 90° F. and tasted by 3 experienced judges. The flavor notation made for each sample represented the consensus of opinion of the 3 judges.

DATA

There are summarized in Table 1 all of the data collected on the samples. Oxidized flavor was the only pronounced off flavor found. Traces of other flavors such as cooked flavor were designated in the table as slight off-flavor. Inspection of the data on flavor shows that of the 139 samples judged, 29 or 20.9 per cent were classified as oxidized to some degree. There were 31 different brands of milk submitted 3 or more times. Of this number 2 consistently had the oxidized flavor; 11 had the flavor sporadically; and 18 were consistently free of the flavor. Oxidized flavor was present in 1 or more samples submitted by 16 of the 19 dairies.

Practical experience has shown that dairies bottling 2 grades of milk have more difficulty with oxidized flavor in the high-fat premium quality milk than in the lower grade.

The data on fat content and flavor in Table 1 have been condensed and rearranged in Table 2. A study of this table shows that in the oxidized

TABLE 2

The incidence of oxidized flavor in milks grouped according to fat content

CLASS INTERVAL-PER CENT FAT	NUMBER OF SAMPLES			PERCENTAGE OF TOTAL			PERCENTAGE OF INTERVAL TOTAL		
	Oxi-dized	Not oxi-dized	Total	Oxi-dized	Not oxi-dized	Total	Oxi-dized	Not oxi-dized	Total
3.6–3.9	2	40	42	6.9	36.4	30.2	4.8	95.2	100.0
4.0–4.3 .. .	4	40	44	13.8	36.4	31.7	9.1	90.9	100.0
4.4–4.7 . ..	9	16	25	31.0	14.5	18.0	36.0	64.0	100.0
4.8–5.1	14	14	28	48.3	12.7	20.1	50.0	50.0	100.0
Total: 3.6–5.1 .	29	110	139	100.0	100.0	100.0	20.9	79.1	100.0

flavor group the largest percentage of samples was found in the high-fat intervals; whereas most of the samples having no oxidized flavor fell in the low-fat intervals.   Considering the 2 extremes, the oxidized flavor occurred in only 4.8 per cent of the samples whose fat content fell in the range of 3.6 to 3.9 per cent fat; while the oxidized flavor occurred in 50.0 per cent of the samples whose fat content fell in the range of 4.0 to 5.1 per cent fat. This appears to be significant since 20.9 per cent of all the samples had the defect.

The relation of fat content to oxidized flavor is presented in Table 3. From the similarity in the range of fat contents of the samples in the 2

TABLE 3

The relation of fat content to oxidized flavor

FLAVOR	PER CENT FAT				NO. OF SAMPLES
	Minimum	Maximum	Mean	Median	
Not oxidized . .	3.6	5.1	4.13	4.0	110
Oxidized	3.7	5.1	4.62	4.7	29
Total	3.6	5.1	4.23	4.2	139

groups it is apparent that the fat content was not an index to the suscepti-bility of any given sample.   This is logical in view of the many factors known to influence the development of the flavor.   Both the mean and the median of the oxidized and unaffected flavor group indicate that this flavor occurs more frequently in the high-fat milks than in the low-fat milks.   The mean and median of the fat contents of all the samples and the group free from oxidized flavor are in the same order of magnitude, indicating the milk of low fat content was not consistently free of the oxidized flavor.

The data concerning the bacteria counts and the flavor are compared in condensed form in Table 4.   It is evident that there was a marked tendency for samples falling in the oxidized flavor group to show considerably lower bacteria counts than those free from oxidized flavor.   This tendency is ex-emplified in both plate counts and direct counts, although it is more in evi-dence in the case of the plate counts.   These observations are generally agreed upon with respect to bacteria counts in relation to oxidized flavor development.

SUMMARY AND CONCLUSIONS

A study was made of the flavor, fat content, and bacteriological quality of 139 samples of commercial pasteurized milk from dairies in 19 different cities during the winter of 1935–1936.   The conclusions were as follows:

1. Oxidized flavor was the predominating "off flavor" encountered and was present in 21 per cent of the samples.

TABLE 4

The relation between bacteria count and oxidized flavor

FLAVOR GROUP	NO. OF SAMPLES	% OF TOTAL	PLATE COUNTS				DIRECT COUNTS			
			Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median
Not oxidized	109	79.0	100	39,000	4,919	1,800	42,000	13,104,000	1,247,330	630,000
Oxidized	29	21.0	100	6,800	1,365	540	42,000	2,604,000	753,000	588,000
Total	138	100.0	100	39,000	4,093	1,300	42,000	13,104,000	1,143,471	630,000

2. The fat content of milk having oxidized flavor was generally higher than the fat content of milks free from this defect.

3. Bacterial counts on milk of oxidized flavor were generally lower than the counts on milk free from this defect.

4. Milks of premium grade, which were generally high in fat content and of low bacterial count, were found to have oxidized flavor much more frequently than the standard grades which were generally low in fat content and of higher bacterial count.

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American Dairy Science Association Announcements

PAPERS FOR ANNUAL MEETING

Titles of papers to be presented at the annual meeting in Lincoln, Nebraska, on June 22 to 25 should be sent in promptly to be received by April 20, while abstracts of the papers should be received before May 1 by Professor H. P. Davis. It has been due to the cooperation of each speaker in submitting abstracts promptly to the chairman of the program committee that it has been possible in recent years to have them ready for distribution at the annual meeting.

WORLD'S DAIRY CONGRESS

"Latest News" from the eleventh World's Dairy Congress to be held in Berlin on August 22 to 28 states that the preparatory and official measures have been completed. Foreign governments have been informed through diplomatic channels and the dairy industry has been informed through an extensive news service.

The International Dairy Exposition will be much more extensive than at previous congresses. Both scientific and practical exhibits will be grouped as follows: 1, exhibition of the nations; 2, industrial exhibits; 3, international quality tests for dairy products, and special exhibits. A "milk-bar" will permit visitors to taste dairy products and dairy dishes of the various nations. The International Quality Show will be limited to butter and cheese of eleven types.

A total of 408 papers have been received from 24 countries. There are 98 papers for Section 1 on milk production and tropical dairying; 166 papers for Section 2 on milk processing and dairy products; 92 papers for Section 3 on legislation, marketing, and education; and 52 papers for Section 4 on machinery, transportation, and buildings. Two novel features will be available, namely, a moving picture film and a book which have recently prepared to show the dairy industry of Germany.

Information may be secured directly from W. Clauss, World's Dairy Congress, Berlin, S.W.68, Lindenstrasse 28 or from O. E. Reed, Chief of Bureau of Dairy Industry, Washington, D. C.

THE INFLUENCE OF SUNFLOWER SILAGE UPON MILK PRODUCTION

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INTRODUCTION

Most recommendations for winter feeding of dairy cows have stressed the importance of providing succulence. This recommendation can be followed without difficulty in the corn belt where heavy yields of ensilage are secured from corn. In regions which are not well adapted to raising corn, however, many difficulties are encountered in providing succulence in the winter ration. Such a problem is faced by the farmers of the northern half of Minnesota where, in many cases, the dairy cattle represent the principal source of cash income. Climatic conditions are such that corn returns poor yields of silage, usually of rather poor quality due to its immature condition.

Root crops return large yields per acre, but require a great deal of hand labor and for this reason are not very practical for the larger herds. In addition, the cost of a root cellar is almost as great as that of a silo. The roots are not as convenient to feed, and spoilage is usually great. Sunflowers have been resorted to as a silage crop in this area but in general have not proven popular.

In most of this region, alfalfa is a reasonably dependable crop and gives good yields of hay of fine quality. Other legumes such as alsike and sweet clover are grown with good success in many sections.

In this section of Minnesota, as well as in many other regions of similar climate, silage is provided, not because it is an economical source of nutrients, but because the succulence which it provides is considered necessary. White and Johnson (3) in discussing the literature upon the question of the importance of succulence in the ration state, "The number of experimental trials on record in which a ration of grain and dry roughage has been compared with a ration containing a succulent feed is surprisingly limited. In

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those trials that have been reported from American experiment stations, moreover, it is found that the evidence is not overwhelmingly in favor of a succulent feed so far as milk yield is concerned. It is evident, therefore, that the preponderance of opinion favoring succulent feeds must be due to practical observations, in part, and to the influence of enthusiastic advocates of a system of feeding in which the great forage producing cereal, corn, is the keystone of the roughage elements of the ration.''

The last sentence of their statement seems to fit particularly well the case of northern Minnesota, which lies just out of the corn belt. Feeding practices found successful in the corn belt area of southern Minnesota may be recommended in the northern part of the state without proper regard for the difference in climatic and other conditions.

This experiment was undertaken with the view of determining whether sufficiently greater returns are secured with the feeding of a succulent feed in the form of sunflower silage to justify the expense necessary to provide it under northern Minnesota conditions.

PLAN OF EXPERIMENT

This work was carried out at the North Central Experiment Station at Grand Rapids, Minnesota. This station is located in the cut-over region, where climatic and soil conditions are typical of a considerable area of northern Minnesota.   .

Sunflower silage was used because it is in general use in this region and usually returns considerably greater yields per acre than corn.

The cows were all purebred or high grade Guernseys. Fourteen cows calving in the fall were divided into two groups of seven each, as nearly alike as possible in age, breeding, date of freshening, size, and milking ability as judged by previous records. All of the animals had previously calved at least twice with the exception of two in each group.

The experiment was continued through two entire lactation periods. During the first lactation the cows of Group 2 during the months of stall feeding received three pounds of sunflower silage per 100 pounds of live-weight, together with all of the alfalfa hay they would clean up readily. The cows of Group 1 were given all of the alfalfa hay they could clean up, but received no silage. During the second lactation the two groups were reversed, the cows of Group 1 receiving sunflower silage and alfalfa hay as roughage, while the cows of Group 2 received alfalfa hay but no silage.

All of the cows were given a grain mixture of equal parts of barley, oats, and standard wheat middlings, with one per cent salt and two per cent bone-meal added. The grain was fed in amounts sufficient to maintain milk production and to keep the weight of the cow as nearly constant as possible with due allowance for advancing pregnancy and for normal growth in the immature animals. The protein content of this grain mix-

ture was found adequate for the requirements of the cows of either group, as the alfalfa hay supplied a considerable amount of protein.

During the pasture season no silage was fed to either group. Cows producing less than 10 pounds of milk daily received no grain while on pasture. Cows producing 10 to 15 pounds of milk received 3 pounds of grain daily, and for each 5 pounds of daily milk production above this amount 2 additional pounds of grain were fed. When the pasture became inadequate to supply sufficient bulk, it was supplemented with alfalfa hay in addition to the grain.

Each cow was started on experiment immediately after calving and gotten on full grain feed as soon as was considered practical. The experimental records were started on the sixth day after calving, counting the day of freshening as the first day. The production and feed records were computed for the following 300 days of the lactation period of each cow, and these data were used in comparing the results with and without silage in the ration.

A third group of five cows freshening during the spring and early summer months was included in order to secure observations under conditions of spring freshening. They were handled in a manner similar to the fall freshening cows, all five of them receiving alfalfa and silage during the first lactation, and alfalfa hay but no silage during the second.

Hay samples were taken monthly and preserved until the end of the lactation period when a composite sample was analyzed. A ten pound sample of silage was taken each month, dried to air dry condition, and a composite sample of the air dry material was analyzed at the end of the lactation period. Similar practices were followed for the concentrates used in the grain mixture, samples being taken each time a fresh lot of feed was mixed.

The average digestibility for each feed as given by Henry and Morrison (1) was used in estimating the amount of digestibile nutrients received by the cows.

The sunflowers were grown on the University Experimental Farm at Grand Rapids. The silage was of good quality and free from mold or spoilage.

The alfalfa hay was of excellent quality, largely second cutting, which would have graded U. S. No. 1. Part of it was grown on the University Experimental Farm, while the rest was purchased locally.

Daily milk weights were recorded, and aliquot parts were taken from each milking for individual composite samples which were tested for butterfat by the Babcock method at ten day intervals.

Each cow was weighed on the first, second, and third days of every month and the average computed. They were also weighed in a similar manner when first turned out to pasture. As far as possible, the cows were maintained at uniform weight from month to month, allowing for

average gains with the advance of gestation and for normal growth of the immature animals.

The cows were bred to freshen approximately 12 months after their previous calving. No grain was fed during the dry period except to cows whose weight was below the weight at freshening time of the preceding lactation.

During the pasture season, all of the cattle were kept in the same permanent pasture night and day except at milking time. The grass was largely native blue grass.

All of the cows were turned out for a short time daily during the winter months unless the weather was stormy or extremely cold, but were never left out long enough to become chilled. Drinking cups were available for each cow, and a supply of salt was before them at all times.

They were milked twice daily at regular intervals and were groomed daily, the same attendants caring for them throughout the entire experiment.

In general, feeding and management conditions were made to conform closely to ordinary farm practices on the better dairy farms of this region.

OBSERVATION AND RESULTS

The first of the fall freshening cows calved September 17, 1931, and the last December 6, 1931.   •

It was found that the cows of both groups consumed much greater quantities of hay than had been expected. When the amount of hay was reduced, the cows would eat the oat straw which was used for bedding.

One cow from Group 1 contracted pneumonia and died during the second year of the experiment. Another cow in the spring freshening group was lost because of a bad case of lump jaw. The remaining cows were in good health and good physical condition and were carried through the entire experiment without any disturbances which might have seriously influenced the final results.

The results of this experiment with the cows freshening in the fall are summarized in Table 1 and Table 2.

It was observed that the production of the cows in both groups was somewhat lower during the second year of the experiment. The only apparent reason for this difference is the fact that pasture was much better during the first year of the experiment. During the summer of 1932, rainfall was adequate for good pasture growth and it was necessary to supplement the pasture only with grain. During the summer of 1933, which fell during the second lactation period of the experiment, rainfall was very inadequate and pasture was poor throughout the season. An average of 970 pounds of alfalfa hay per cow was fed duirng the pasture season of 1933, in addition to the grain supplement. Both groups behaved similarly,

TABLE 1

Production and feed consumption during first 300 days of lactation for 13 cows freshening during fall and early winter months. (Succulence provided in the form of Sunflower Silage during winter months.)

COW NO.	AVE. LIVE WEIGHT	CARRIED CALF	ON PASTURE	PRODUCTION			FEED CONSUMED			DRY MATTER CONSUMED	DIGESTIBLE NUTRIENTS RECEIVED	
				Milk	Fat	Fat	Grain	Alfalfa	Silage		Protein	Total
	lbs.	days	days	lbs.	per cent	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
				Group 1 (1932–1933)								
6	1012	207	128	7664	4.09	313.9	2365	3722	5397	6897	725	4400
17	894	192	75	6350	4.46	283.6	2051	3613	6772	6846	696	4279
12	1023	184	110	6618	4.25	281.7	2167	3105	5775	6233	641	3987
8	986	190	127	5741	5.00	287.4	1983	2228	5180	5115	522	3314
28	812	219	128	7298	4.02	293.5	2221	2634	4218	5453	574	3544
30	879	227	128	5981	4.08	244.1	1857	2489	4443	5060	526	3257
Average	934	203	116	6607	4.30	284.0	2108	2963	5297	5932	614	3797
				Group 2 (1931–1932)								
10	1107	215	103	6608	3.97	262.4	2392	3410	5510	6795	698	4877
11	970	162	93	5095	4.53	231.2	1608	4461	5962	6973	682	4195
21	1020	143	91	5364	3.85	206.8	1623	4365	6057	6918	646	4212
19	955	115	77	6452	4.34	270.6	2133	4199	6057	7220	717	4516
2	1155	229	114	9220	3.74	345.2	2439	5347	5377	8735	909	5732
29	788	223	107	4753	4.39	208.9	1216	4053	4507	5599	579	3599
27	844	227	57	6437	3.57	230.3	1684	4118	6459	6828	662	4052
Average	977	188	92	6276	4.00	250.8	1955	4259	5708	7052	699	4458
				Group 1 and Group 2								
Total Average	957	195	103	6429	4.14	266.1	2025	3672	5519	6535	660	4153

TABLE II

Production and feed consumption during first 300 days of lactation for 13 cows freshening during fall and early winter months. (No succulent feed provided during winter months.)

COW NO.	AVE LIVE WEIGHT	CARRIED CALF	ON PASTURE	PRODUCTION			FEED CONSUMED			DRY MATTER CONSUMED	DIGESTIBLE NUTRIENTS RECEIVED	
				Milk	Fat	Fat	Grain	Alfalfa	Silage		Protein	Total
	lbs.	days	days	lbs.	per cent	lbs.	lbs.	lbs	lbs.	lbs	lbs	lbs
Group 1 (1931–1932)												
6	980	71	114	5468	4.09	233.8	1257	6448	—	7044	765	4241
17	839	114	90	4065	4.84	196.8	886	6188		6466	692	3811
12	996	195	114	5030	4.02	202.6	1091	6195		6651	727	4027
8	972	196	114	4933	4.72	232.9	1458	5163		6062	687	3852
28	850	210	114	7554	3.96	299.4	2391	5722		7415	826	4692
30	956	227	114	5921	3.99	236.4	1818	5561		6765	743	4197
Average	932	169	110	5495	4.22	232.0	1483	5879		6734	740	4137
Group 2 (1932–1933)												
10	1052	240	106	7516	4.09	307.4	2333	4513		6244	730	4101
11	975	202	64	6053	4.78	289.9	1971	5159		6794	790	4271
21	966	228	92	6365	4.04	257.6	2018	4865		6289	732	3987
19	923	235	95	7455	4.42	329.6	2442	5047		6834	797	4394
2	1116	31	54	9757	4.03	393.2	2970	7050		9149	1068	5838
29	814	232	115	5641	4.51	254.4	1646	3677		4862	568	3105
27	779	222	51	6873	3.59	246.8	2009	4682		6109	706	3892
Average	946	199	82	7094	4.19	297.0	2199	5042		6612	770	4227
Group 1 and Group 2												
Average	940	185	93	6356	4.20	267.0	1868	5425		6668	756	4170

however, and when the results of the experiment were summarized it was observed that the average production of all of the cows was almost identical for the lactation period when silage was fed and the lactation period when it was not fed. Total milk production averaged 73 pounds per cow greater when silage was fed. but total butterfat production was 0.9 pound less. Such close agreement between the yields of two successive lactations could hardly be expected. even if treatment were identical, and certainly these results give no indication that the feeding of a succulent feed in the form of sunflower silage influenced the production of the cows in any way. An average of 17 pounds more of digestible nutrients per cow was fed during the lactation period when the ration included no silage and the dry matter consumption was 133 pounds per cow greater. The protein intake was 96 pounds per cow greater due to the fact that alfalfa was fed in greater amounts. The average live weight was 17 pounds greater during the silage feeding period and the cows carried their calves 10 days longer, but they averaged 8 days longer on pasture. It would probably be safe to say that the difference in intake of dry matter and of digestible nutrients is not significant. No difference in health, appetite, or general condition was observed to be associated with silage feeding.

The results with the 4 cows completing the experiment in the spring freshening group are shown in Table 3. In view of the results with the fall freshening groups it seems probable that the greater milk yield during the first lactation was due entirely to the more favorable pasture season rather than to the feeding of silage. This group was probably more seriously affected than the fall freshening groups, since the poor pasture conditions reduced milk flow during the stage of lactation when production is normally at its peak.

DISCUSSION

The results of this experiment give no evidence of any appreciable effect, either favorable or unfavorable, of sunflower silage other than that due to the digestible nutrients which it contains. If this is the case. the question becomes largely a problem of farm management and one which will be determined largely by local conditions. Under the conditions of this experiment, 5519 pounds of silage and 157 pounds of grain apparently served the same purpose as 1756 pounds of alfalfa. Using prevailing local prices for alfalfa hay and for the constituents of the grain mix, the sunflower silage had a cash value at that time of about $2.25 per ton on the basis of the hay which it replaced.

Pond and Crickman (2) give the standard requirement for producing 1 acre of sunflower silage in Northeastern Minnesota as 30.1 man hours and 55.2 horse hours with a yield of 8 tons. An acre of alfalfa was found to require 12.2 man hours and 17.4 horse hours with a yield of 2.5 tons.

TABLE III

Production and feed consumption during first 300 days of lactation for 4 cows freshening during spring and early summer months.

COW NO.	AVE. LIVE WEIGHT	CARRIED CALF	ON PASTURE	PRODUCTION			FEED CONSUMED			DRY MATTER CONSUMED	DIGESTIBLE NUTRIENTS RECEIVED	
				Milk	Fat	Fat	Grain	Alfalfa	Silage		Protein	Total
	lbs.	days	days	lbs.	per cent	lbs	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1931-1932 (Silage included in ration)												
4	958	241	103	6928	4.17	289	2206	3681	5692	6773	700	4305
1	1012	193	73	7530	4.27	322	2599	4467	6580	8068	835	5121
3	1090	207	91	8612	4.00	345	2797	4706	6116	8348	857	5212
25	947	219	83	5595	4.37	245	1750	3974	6350	6803	693	4189
Average	1002	860	87	7166	4.19	300.1	2338	4207	6195	7498	771	4707
1932-1933 (No silage in ration)												
4	961		69	6156	4.07	251	1369	4717		5527	613	3416
1	904	182	53	6021	4.13	249	1469	6507		7246	798	4422
3	1115	180	83	8074	3.69	298	2192	6435		7832	873	4895
25	983	210	91	5458	4.17	223	1338	6082		6741	743	4110
Average	991		74	6427	3.97	255.2	1392	5935		6837	757	4211

Using the figures obtained from the analysis of the sunflower silage and alfalfa hay used in our experiment, an acre of alfalfa yielding 2.5 tons would contain 498 pounds of digestible crude protein and 2599 pounds of total digestible nutrients. An acre of sunflowers producing 8 tons of silage would yield 206 pounds of digestible crude protein and 2118 pounds of total digestible nutrients. Requiring less than one half the labor, alfalfa yields a greater quantity of nutrients per acre and more than twice as much protein. Another very important factor is the expense of erecting and maintaining the silo and the expensive equipment required for filling. This is particularly important in the region where this investigation was carried out, since the small cultivated fields are not adapted to use of power equipment and the low cash income often makes purchase of expensive equipment prohibitive. In addition, the fertility of the soil is conserved to much better advantage when alfalfa or other legumes are grown than if sunflowers are grown as a silage crop.

In view of these facts, it seems that the importance of growing legume hay for dairy cows should be stressed in any region where legumes will grow successfully and that the use of silos should not be recommended indiscriminately to dairy farmers in regions which are not well adapted to growing silage crops, merely on the basis of providing a succulent feed.

This conclusion is borne out by recent work at the Connecticut (Storrs) Station by White and Johnson (3). In view of their findings, however, it appears that particular care should be taken to provide a plentiful and ever accessible supply of water for the cows even if a succulent feed is fed, and particularly if dry roughages are used entirely.

This should not be interpreted, however, as minimizing the importance of the silo for preserving to the best advantage the large quantities of roughage produced in the corn belt where the production of silage fits in well with the farming program. Undoubtedly the silo will increase in popularity in regions where weather conditions render field curing of hay very uncertain. This is particularly true in view of recent developments in the preservation of legume crops in the silo, by use of acid or by addition of molasses. There does not appear to be justification, however, for recommending the use of the silo where it will add materially to the cost of producing milk merely because of the physiological need of the cow for "succulence" in her winter ration.

SUMMARY AND CONCLUSIONS

In a group of 13 cows, no advantage in milk production or in health and condition of the cows was found due to inclusion of sunflower silage in the ration containing an abundant supply of legume hay and with water supplied by means of drinking cups. Succulent feed does not appear to be essential for satisfactory production, and it may be inadvisable to attempt

to provide succulent feed when conditions are such that it will add materially to the cost of milk production.

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WRAPPERS FOR PROCESSED CHEESE

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In the preparation of cheese for the processing operation, the rind or outer portion of the cheese unit is removed and its place is taken on the finished product by a so-called wrapper. The purpose of this material is to prevent the access of mold spores to the surface of the cheese, to retard the escape of moisture from the cheese and to serve as a container for a unit mass of cheese which may be sold as such. In addition the wrapper may also serve as an advertising space which if properly used may greatly enhance the appearance of the packaged cheese.

In the selection of a material to be used as a wrapper for processed cheese there are a number of factors that must be given consideration. namely:

1. The wrapper must give a uniformly close seal with the cheese mass so as to eliminate as far as possible air pockets between the wrapper and the cheese.

2. The wrapper must retain the moisture in the cheese so as to prevent drying of the surface and consequent loss of weight.

3. The edges of the wrapper must cling together to prevent access of molds.

4. The wrapper must not impart any off-flavor or color to the cheese.

5. The wrapper should not be affected by the cheese mass in any way.

6. The wrapper should give a pleasing appearance to the cheese unit.

7. The cost of the wrapper should be as low as possible and at the same time the material used should meet all the enumerated requirements.

Before taking up the discussion of the different materials that have been suggested and tried as wrappers for processed cheese, it is desirable to know something of the conditions which exist in the cheese mass. The cheese comes in contact with the wrapper in a molten condition at pasteurizing temperature and the wrapper is then closed about the cheese mass as rapidly as possible. Since there is some evidence that too rapid cooling of the cheese may result in syneresis, it is customary to allow the wrapped unit to cool rather slowly. Thus there is greater opportunity for interaction between the cheese and the wrapper. The cheese mass is somewhat acid in reaction depending upon the type of cheese that is used, and in addition it contains the salts that have been used to facilitate the melting process. While the temperatures involved are relatively low and the total salt con-

tent of the water-free cheese mass seldom exceeds 10 to 11 per cent, of which 6 to 7 per cent represents the salts present in the cheese before the addition of the emulsifier, there is ample opportunity for reaction between the cheese mass and the wrapper. In connection with the effect of added salts on foil corrosion it may be of interest to mention the work of Csiszar (1) on the use of preservatives in which he points out that such preservatives as common salt, saltpeter and sulfurous acid, when used in amounts sufficient to prevent the spore germination of butyric acid-forming bacteria in the cheese mass, gave a very marked corrosion of the tin-foil wrapper. As a result of the interaction between the foil and the cheese mass, some of the former may be found in the surface layer of the cheese and there may be microscopic and macroscopic evidence of changes having taken place in the wrapper.

Tin foil has been quite universally used as the wrapping material for processed cheese since the beginning of the industry and its cost has been a very important item in the production of the finished product. The cost of the tin foil has served as a stimulus to investigations on the subject of other materials that might be used for processed cheese. There is no record available of all the foils and similar materials that have been tried experimentally, but the cost factor has undoubtedly served to eliminate a number of the metal foils. Certain of the cellulose and rubber composition films have been suggested as wrappers for processed cheese. Their use has not been found very satisfactory since there seems to be a reaction between the wrapper and the cheese mass which gives a very peculiar and rather disagreeable taint to its surface. That this defect is primarily due to heat may be inferred from the fact that when cheese is wrapped in a film of this nature it is usually necessary to use some heat to bring about the adherence of the foil to the cheese. This treatment has resulted in the surface of the cheese acquiring the same bitter taint as has been noted with the processed cheese. When adherence can be brought about by other means, the degree of surface taint has been notably decreased. For this reason the rubber and cellulose composition films have not been used in the processed cheese industry.

In the years that tin foil has been used as a wrapper for processed cheese it has been the subject of a number of investigations in regard to the defects which may appear on or in the foil and the changes which may be imparted to the cheese mass. The average commercial tin foil that was used in reported European investigations contained about 97 per cent tin, about 3 per cent antimony, with a trace of lead and slight amounts of iron and copper. The antimony and lead were added to the tin for technical reasons to increase the strength of the tin. The former is generally mentioned by all investigators as being closely connected with the most common defect that has been noted in the use of tin foil, namely, the darkening of the foil. This

defect ranges from a negligible dulling of the surface of the foil to a decided black coloration which may involve the entire surface of the foil or may be localized to a number of spots. Various investigators do not agree as to the cause of the darkening, some attributing it to an acid reaction of the cheese mass or the use of an acidic emulsifying salt (2), while others feel that insufficient acidity causes the foil to darken (3). In connection with the latter suggested explanation the idea has been advanced that there is a decomposition of the casein with formation of salts of hydrogen sulfide (4). Since lead sulfide is black it has been assumed that this is the substance noted on the tin foil. However, the amount of lead that is present in the tin foil would seem insufficient to account for the intensity of color that is often found.

The explanation for the darkening of the tin foil that seems to be the most satisfactory represents a combination of circumstances and effects; there is a galvanic cell set up between the tin and the antimony (5) with a partial solution of the tin, and the salts formed in combination with oxygen give the blackening of the foil. Analyses of processed cheese samples that have been wrapped in tin foil show an increase in the tin content of the surface layer of the cheese (6). To prevent the solution of the tin, some countries, notably England, require that the surface of the foil in contact with the cheese be coated with a shellac or other material similar to that used for the lacquering of tin cans to prevent interaction between the contents of the can and the container. This remedy has proven satisfactory for reducing the solubility of the tin in the cheese and at the same time the blackening of the foil has been practically eliminated unless the protective film is destroyed.

That oxygen is important in the darkening of the foil is indicated by the fact that the black spots often noted on the foil are found over the air pockets in the surface of the cheese mass. If the foil is removed from the cheese and then replaced there will be a decided increase in the discoloration, which is not apparent if the foil is not brought in contact with the cheese a second time (5).

The salts that are used in the manufacture of processed cheese may accelerate the discoloration of the foil. This is shown in Table 1 in which the samples of cheese were made up with varying amounts of different emulsifiers and the finished product wrapped in a good grade of commercial tin foil. The foils were carefully examined when removed from the cheese samples after less than one month in storage, after 4 months and again after approximately 11 months. The results of these examinations together with the amount of salts used, the pH of the cheese mass, and the total ash content of the cheese on a water-free basis are presented in Table 1.

The results of this investigation indicate that the discoloration of the tin foil is rather closely related to the use of phosphates as the emulsifying

TABLE 1

The effect of various emulsifiers and the reaction of (pH) of the processed cheese on the discoloration of the tin foil

SAM PLE NO	EMULSIFIER		PH. QUINHYDRONE		PER CENT ASH IN THE DRY MATTER	FOIL DISCOLORATION ON		
	Kind	Per cent	Cheese paste	1:10 Sus pension		First exam	Second exam	Third exam
1	Control	--	5.43	5.86	7.08	--	--	--
2	Sodium citrate	1.0	5.48	5.97	7.38	--	--	--
3	" "	2.0	5.62	6.12	8.07	--	--	--
4	" "	3.0	5.65	6.15	8.68	--	--	+-
5	" "	4.0	5.78	6.30	9.30	--	--	+
6	" "	5.0	5.99	6.37	10.08	--	--	+
7	Potassium citrate	3.0	5.68	6.15	9 16	--	--	+
8	" "	2.5	5.68	6.19	8.99	--	--	+
9	" "	2.0	5.61	6.12	8 46	--	--	+
10	" "	1.5	5.57	6.03	8.01	--	--	+
11	" "	1.0	5.55	5.95	7.73	--	--	+-
12	Tetra-sodium	5.0	6.03	6 49	13.05	+	++	++
13	Pyro-phosphate	4.0	6.02	6.52	12.71	+	++	++
14	" "	3.0	5.96	6.40	11.51	+	+	+.
15	" "	2.0	5.74	6.26	9.90	+	++	++
16	" "	1.0	5.60	6.12	8.58	--	+	+
17	Sodium	5.0	5.30	5.80	12.05	--	+-	+
18	Meta-phosphate	4.0	5.21	5.65	11.68	+-	+-	+
19	" "	3.0	5.20	5.68	10.40	+-	+	+
20	" "	2.0	5.27	5.72	9.49	--	+	+
21	" "	1.0	5.36	5.78	8.28	--	+-	+-
22	Mono- and di-sodium	2.0	5.32	5.77	9.24	--	+-	--
23	Ortho-phosphates	1.0	5.34	5.75	8.25	--	--	--

Explanation of symbols: ++ marked discoloration, black spots.
+ general discoloration.
+ – slight, but noticeable discoloration.
– – no discoloration.

agents for processed cheese and to a pH value more alkaline than 5.8 (cheese paste, no dilution) or 6.25 (1 to 10 suspension of cheese in water). This is further confirmed by the results of a comparison of sodium citrate with di-sodium phosphate (ortho) which was made on a number of cheeses processed at various ages, Table 2. All of the cheeses in each series were made from the same original milk. While the amounts of emulsifiers were somewhat larger than commonly employed the additions were calculated to include the water of crystallization in the salts used so that the results are comparable on the basis of the actual salt content of the samples. The samples of the processed cheese were examined after the storage periods indicated. The quality of the original cheese was not exceptional in any way. With the very young and old cheese the samples were so greasy that it is

TABLE 2

The effect of sodium citrate and di-sodium phosphate (ortho) with cheese of varying ages on the discoloration of the tin foil

AGE OF CHEESE	SODIUM CITRATE (2 PER CENT)***			DI-SODIUM PHOSPHATE (2 PER CENT)***		
	pH*	Storage days	Discoloration	pH*	Storage days	Discoloration
1 day	5.93	3	none	6.21	1	none
		41	"		41	"
		124	"		124	"
		183	"		181	slight
3 days	5.97	1	none	6.20	2	none
		40	"		38	"
		124	"		122	"
		181	"		179	yes
8 days	6.13	7	none	6.28	5	none
		35	"		33	"
		119	"		117	yes
		175	"		173	"
8 days**		5	none, 10 days**		5	none
	5.95	33	none	6.19	33	"
		117	"		117	yes
		173	"		173	"
1 mo.	6.11	4	none	6.37	2	none
		95	"		93	yes
		160	"		158	"
		209	"		207	"
2 mo.	6.23	4	none	6.40	2	yes
		33	"		31	"
		63	"		61	"
		129	"		128	"
3 mo.	6.13	1	none	6.36	1	yes
		31	"		31	"
		58	"		58	"
		97	"		97	"
6 mo.	6.25	4	none	6.38	4	slight
		54	"		54	too greasy
		81	"		81	yes
		128	"		128	"
9 mo.	6.26	4	none	6.42	4	none
		38	"		38	yes
		66	"		66	"
		105	"		105	"

* pH determined on a suspension of one part cheese in ten parts of water.

** In these samples the emulsifiers were reversed, that is the cheese that was usually processed with sodium citrate had di-sodium phosphate added and vice versa.

*** Computed on the basis of anhydrous salt.

possible that the fat may have prevented a more pronounced discoloration in the foil. Both Tables 1 and 2 show that the more acid reaction was not

associated with discoloration of the tin foil as often as reactions on the more alkaline side of the limits mentioned. Samples of processed cheese made up with the addition of free acid failed to show discoloration of the foil unless the amount of acid used was such that the body and texture of the resulting processed cheese was affected.

Aluminum foil has been used as a wrapper for processed cheese in an effort to avoid the darkening defect observed with tin foil. In pure form the aluminum foil is rather easily corroded by the action of the cheese salts but the aluminum salts are colorless so that their presence is not readily noted. Certain shellacs and resins have been used as a protective coating on the aluminum foil to prevent corrosion with sastisfactory results. German manufacturers have been active in this field, and as a result of their researches offer aluminum foils with various types of coatings for the prevention of the corrosion of the aluminum foil, and claim to have a coating that facilitates the handling of the foil by the automatic packaging machines used in the processed cheese industry (7). One of the major criticisms of aluminum foil is that it does not behave satisfactorily in the automatic packaging machines. The aluminum foil is somewhat more rigid than tin foil and therefore does not cling to the cheese mass as closely. This may result in air pockets which in turn may be places for mold growth and a loss of moisture from the cheese mass. The latter usually takes place rather slowly so would not cause appreciable loss if the cheese were sold soon after manufacture.

Lead foil has been tried experimentally as a wrapper for processed cheese without success as both the foil and the surface of the cheese were badly discolored after a few days. One investigator has identified lead as being the cause of black spots in the cheese mass (8) but the source of the lead was not the wrapper.

In making a comparison of a number of wrappers, the following materials were used: commercial tin foil, aluminum foil coated with a proprietary resin film, aluminum foil with a dull finish on one side due to the use of another type of protective coating, a rubber composition film and a cellulose film. These wrappers were used with samples of cheese made up with 2 and 3 per cent additions of sodium citrate, di-sodium phosphate (ortho) and tetra-sodium pyrophosphate. Examination of the samples within ten days after making showed that there was no surface taint in the cheese wrapped in tin foil or the aluminum foil with the protective resin film, but all of the other samples showed a noticeable surface taint.

The seal between the foil and the cheese, and the ability of moisture to diffuse through the foil is of commercial importance since a poor seal may result in mold growth and the loss of moisture give a dry surface to the cheese which is not desirable. In this experiment the storage time was not sufficient to permit any extensive mold growths or appreciable loss of

moisture. The average moisture contents of the six samples of cheese in the five types of wrappers are presented in Table 3. From this it is evident that wrapper "E" was somewhat less effective than the others. This

TABLE 3

Average* moisture content of processed cheese samples with various types of wrappers

"A" TIN FOIL	"B" ALUMINUM FOIL RESIN FINISH	"C" ALUMINUM FOIL DULL FINISH	"D" RUBBER COMPOSITION	"E" CELLULOSE COMPOSITION
40.25	40.10	40.35	40.33	39.42

* Each figure represents the average of 6 determinations made 6 to 10 days after processing.

may have been due to diffusion of moisture through the foil and also to the fact that this foil was the most difficult to handle when lining the boxes.

SUMMARY

From the foregoing discussion it is evident that there are a number of factors which play a part in the darkening of the tin foil. The use of phosphate emulsifying salts appears to accelerate the discoloration, especially when the reaction of the cheese-quinhydrone paste is more alkaline than pH 5.8. The results presented in this paper were obtained from investigations on Cheddar cheese, and it is probable that other types of cheese might show different reaction values which are connected with the darkening of the tin foil. It is also probable that there may be some other factors involved, which may be studied at a later date.

It is also evident that the metal foils are still superior to any other type of foils as a wrapper for processed cheese. For general use with all types of cheese tin foil is probably more satisfactory than aluminum foil, but when relative costs are considered there may be types of cheese with which aluminum foil, properly coated to prevent corrosion, may offer distinct advantages.

In conclusion the authors wish to express their thanks to Chas. Pfizer & Co., Inc., for the fellowship under which this investigation has been conducted and also to those who supplied samples of wrappers for this experiment.

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THE MICROBIOLOGICAL FLORA ON THE SURFACE OF LIMBURGER CHEESE* †

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The common practice in limburger cheese factories is to take the cheeses from the salting tables the second or third day after making and pack them together on the shelves of the ripening room. From this time on the cheeses are turned and rubbed with the hand daily, or at short intervals, until they are ready for packing when they are wrapped in parchment and waxed paper and placed in cold storage until ready for distribution.

As the humidity of the ripening room is high, and the temperature is maintained close to 15.5° C. (60° F.) conditions are ideal for the growth of microorganisms. The method of salting leaves a high concentration of salt on the surface of the cheese which tends to inhibit the growth of all but salt tolerant organisms.

A short time after being put on the shelves, the cheeses become slimy and as they are rubbed from day to day the surface becomes smooth and the edges are rounded. Some days later a reddish color appears which spreads over the whole surface as the rubbing continues. This color has been found to vary in different districts of New York State from a reddish-brown to orange.

The bacteria found in the surface smear of limburger and related types of cheese have been studied extensively in Europe. In 1898 Weigmann (1) found *Clostridium licheniforme* and *Paraplectrum foetidum* on the surface of the cheese and considered them as growing in metabiosis, the former preparing the way for the latter by breaking down the lactic acid and making the medium more alkaline. He believed that *Paraplectrum foetidum* was responsible for the typical cheese aroma and flavor. Recently Weigmann (2) stated that a red smear was built up by red bacteria which covered the surface of the cheese and produced anaerobic conditions permitting the growth of *Paraplectridium or Plectridium foetidum*.

In 1899 Laxa (3) working with Bohemian varieties of limburger cheese found *Oidium lactis*, lactic acid bacteria, *Saccharomyces*, and a yellow-pigment producing rod. His conclusions were that *Oospora lactis* consumed the free acid and thus prepared the cheese for the other bacteria. These

other microorganisms growing together in symbiosis produced the characteristic odor and flavor of the cheese.

Orla Jensen (4), (5) in studies on limburger cheese found *Oospora lactis* in young cheese though he did not consider them as having any part in the ripening. He also found a number of peptonizing bacteria, chiefly *Tetrococcus liquefaciens*, a small spore-forming rod, and yeasts growing together with a rod which he calls *Bacterium casei limburgensis*. From data which he presents he concludes that *Tetrococcus liquefaciens* and *Bacterium casei limburgensis* are responsible for the ripening of the cheese. Orla Jensen (5) states "It is obvious that under normal conditions organism other than those mentioned above participate in the process. Weigmann mentions *Plectridium foetidum* but whether their activity is to be regarded at all desirable may be an open question; it is quite possible that limburger cheese might have a wider market if it contained no products of putrefaction."

Wolff (6) in his investigations on the cause of the orange color in the smear on the surface of cheeses found yellow micrococci and sarcina together with orange and lemon yellow rods. He also found short rods which produced a red-brown pigment and which he designated as *Organismus IX*. Wolff considers this *Organismus IX* as being largely responsible for the red color of the surface smear. In 1910 Wolff (7) at Weigmann's suggestion named this organism *Bacterium linens*.

Filipović (8) made a thorough study of Schwarzenberger, Hagenberger, and Romadour, three limburger types of cheese. In his review he considers certain *Torula* and *Mycoderma* which he found, as having a significant role in preparing the surface of the cheese for the peptonizing rods which later develop in the surface smear. These rods and more especially *Bacterium linens* are responsible for the typical limburger flavor and color. He did not find *Oospora lactis* in the Romadour cheese.

During the early part of 1936 contact slides were made from cheese from each day's make in each of fourteen New York State limburger factories in two different districts. As there was some difference in appearance in the cheeses made in the two districts they are called, for convenience, District 1 and District 2. The contact slides were made by pressing slides against the surface of the cheese until a sufficient amount of the slime adhered to them. They were then allowed to dry and after treating with xylene to extract the fat and with alcohol to harden the smear were later stained and examined under the microscope. By this method it was possible to determine day by day the types and relative numbers of organisms found on these cheeses throughout the time of ripening in the factory. While it should not be assumed that the daily changes shown on a series of cheeses are identically the same as the changes that take place on any individual cheese, still the preparations from a single factory should give

a reasonably accurate picture of the changes that take place on an average cheese from that factory.

The chief difference noted in the cheeses from the two districts was that those from District 1 had a reddish-brown color, while those from District 2 which were softer, more moist, and salted later, developed an orange color. The difference seemed to be related to the lower temperatures in the cellars of District 2 where the cheese ripened much more slowly.

While most of the slides were stained by Hucker's modification of the Gram stain (9) butyl alcohol was used for several series in place of ethyl alcohol as it cleared the background, leaving the organisms more distinct. With this modification of the stain all organisms are gram positive.

RESULTS

Slides from one-day-old cheeses in all series showed budding yeast-like organisms, cocci (mostly in pairs), and rods in about equal numbers (Plates 1 and 2). The yeasts increased rapidly in number until they appeared in
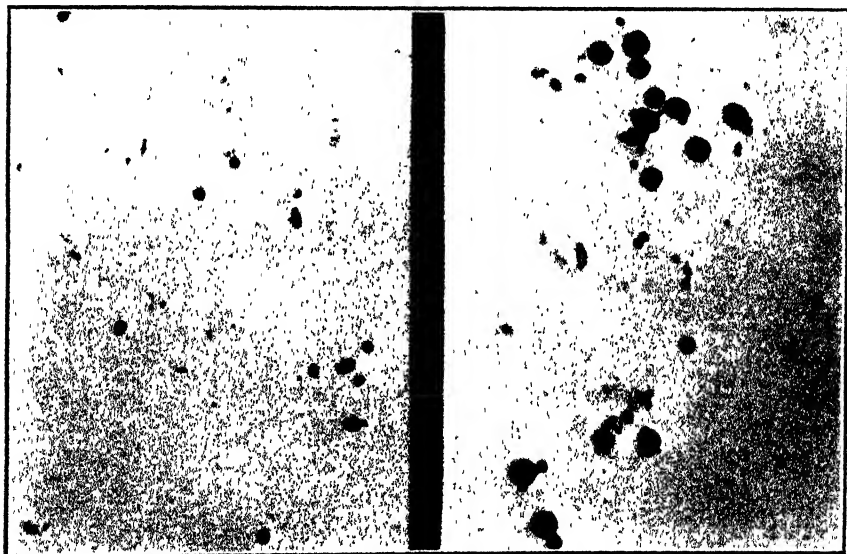
PLATE 1. From cheese one day old showing yeast, rods, and cocci. Magnification 510 ×.

PLATE 2. From cheese one day old. Magnification 1000 ×.

large masses on the cheeses that were two days old (Plates 3 and 4). At the same time the surface of the cheeses became quite slimy. At a later date, and coincident with the appearance of the red color, short slender rods were found to be growing among the yeast cells (Plate 5) and increasing in num-

PLATE 3. From cheese two days old showing yeasts making rapid increase. Magnification 510 ×.
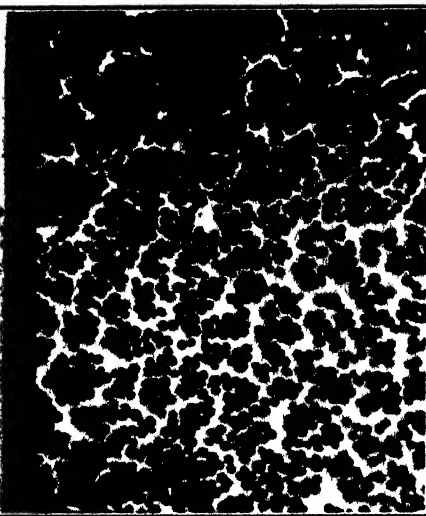
PLATE 4 From cheese four days old showing yeast in masses. Magnification 510 ×.

PLATE 5. From cheese six days old showing yeasts in masses and short rods in fairly large numbers. Magnification 510 ×.
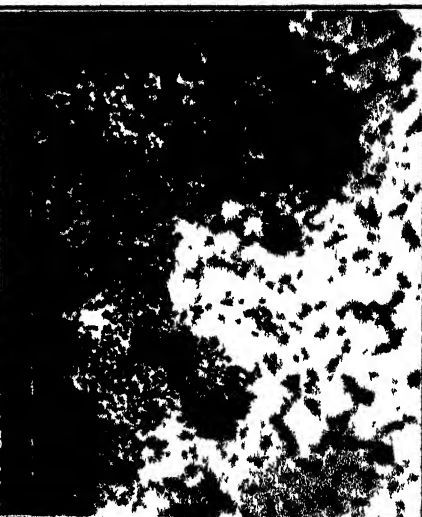
PLATE 6. From cheese eight days old showing short rods in large masses. Yeasts were to be found in large numbers though they do not appear in this field. Magnification 510 ×.

ber soon overgrew the yeasts (Plate 6). In time the yeasts tended to die out and the yeast cells were found mostly as poorly stained or distorted forms (Plate 7) while the rods increased until there was a solid mass of bacteria (Plates 6 and 7). The bacteria are found in large numbers up to the time the cheese is consumed.

Oospora were occasionally encountered and in every case where they were found in any number, the cheese showed the peculiar wrinkled appearance associated with the growth of *Oospora lactis*. On the cheese from District 1, very few organisms other than yeast and the short rods were to be found after the first few days, but with the cheeses from District 2 quite a number of larger and thicker rods, and other miscellaneous bacteria were to be noted from time to time; and this more especially during the first week of ripening (Plate 8).
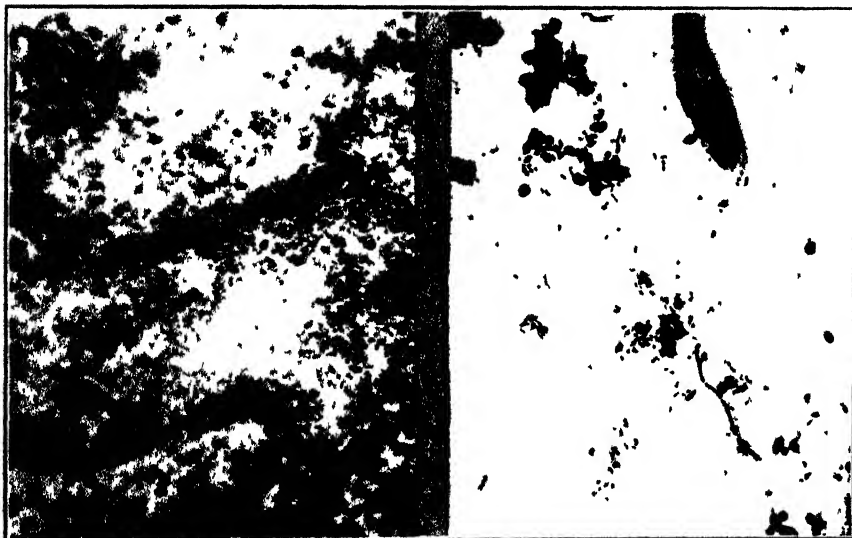
PLATE 7. From cheese seventeen days old showing rods in masses and yeasts starting to break down. Magnification 510 ×.

PLATE 8. From cheese made in District 2 showing besides yeast, types of bacteria other than the short rods. Magnification 510 ×.

In District 1, the yeast cells appeared in considerable number on cheeses two to four days old with the majority of cheeses three days old. They reached what seemed to be their maximum number at from four to six days, with an average time of less than five days. On the other hand, though the yeast cells in District 2 made their first appearance at two to three days, they developed more slowly and reached their maximum growth at four to eight days.

The time of the first definite appearance of the rods on the cheese in District 1 showed considerable variation, being from four to eight days, while in District 2 they appeared from the sixth to eighth day. The maximum growth in both districts occurred between the fifth and the tenth day.

The yeast cells started to disappear around the tenth to eighteenth day, but a few were to be found throughout the ripening period.

Cultures of the yeast and of the rod-shaped bacteria have been isolated and a preliminary study has been made of them.

The yeast was found to reproduce by budding, showed no trace of sexuality, spores were not found when grown on gypsum blocks, a pellicle was formed on liquid media from the beginning, and salt was tolerated in concentrations as high as 18 to 20 per cent.

The bacteria are gram positive and tolerate concentrations of salt as high as 18 to 20 per cent. They agree morphologically and in their cultural and physiological characteristics with the description of *Bacterium linens* as given by Wolff and by Steinfatt, the one exception being that no orange-colored ring was observed in milk.

Bacterium linens Weigmann. (Organismus IX, Wolff, Milchwirt. Zent., *5*, 145, 1909; in Wolff, Cent. f. Bakt., II Abt., *28*, 422, 1910, and in Weigmann, Mykologie der Milch, *62*, 220, 1911.

Description taken from Wolff, Milchwirt. Zent., *5*, 145, 1909, and Steinfatt, Milchwirt. Forsch., *9*, 7, 1929.

Rods: 0.6×0.8–1.0 micron without spores, non-motile (Wolff) are somewhat irregular in form and size when grown in liquid media (Steinfatt).

Agar colonies: At 30° C. small colonies are formed and are about 1 mm. in diameter in ten days, shiny, brownish, translucent droplets. Brownish yellow on cheese agar.

Agar slant: At 20° and 30° C. growth good though slow, translucent, shiny, red-brown or reddish-yellow.

Gelatin colonies: At 18° C. punctiform at first and in about twelve days about 1 mm. in diameter. Colony compact, shiny, circular, brownish-yellow to red-brown in color. The gelatin is liquefied.

Broth: The broth becomes cloudy in time.

Milk: At 20° and 30° C. little or no change to be observed after ten days. An orange-colored ring is produced around the wall of the tube, more pronounced at room temperature than 30° C. A reddish-yellow sediment is found at the bottom. The reaction is alkaline.

Potato: After 2 days scanty shiny orange growth in the form of droplets. The potato is mouse-gray in color.

No acid from glucose, lactose, saccharose, galactose, glycerin, mannite, arabinose, raffinose, dextrin and salicin (Steinfatt).

Aerobic.

Temperature relations: Maximum 37° C., optimum 25° C., minimum 9° C.

Distinguishing characters: Produces a shiny orange growth on agar.

Source: This organism represents 10 per cent of a large number of cultures isolated by Wolff from Rahmkäse (a ripened cream cheese).

Habitat: Produces the red-brown slime which covers surface-ripened cheese.

DISCUSSION

As the yeasts and short rods appeared almost in pure culture on the surface of the cheeses in many of the factories where the best cheeses were made, it is logical to suppose that only these organisms are necessary for the surface ripening of the type of cheeses made in New York State. Proper salting of the cheeses as early as possible leaves a sufficiently high concentration of salt to exclude all but these salt tolerant organisms. Where salting is delayed as in many factories in District 2 other microörganisms besides yeasts and *Bacterium linens* may become established on the unsalted curd and be found in considerable numbers throughout the ripening period (Plate 8). These other organisms, while apparently not necessary to the proper ripening of the cheese have not been shown to have a detrimental effect as the quality of the cheese was good. The slower development of both the yeasts and the rods in District 2 is explained by the lower ripening temperatures.

Details of the part played by the yeast and *Bacterium linens* in the ripening of the cheeses are beyond the field of this study, and can only be determined by further research. Undoubtedly, however, through their enzymes they have a major part in the breaking down of the cheese mass from the firm rubbery texture of green cheese to the soft buttery consistency of the ripened cheese.

SUMMARY

The microbiological changes on the surface of ripening New York State limburger cheese as found by microscopic examinations show a very definite sequence. Budding yeasts appear in from two to three days and are found in large masses in four to five days. At this stage the surface of the cheese becomes slimy and the organisms in this slime are distributed evenly over the surface by rubbing the cheeses with the hands.

About the sixth or seventh day short slender rods (*Bacterium linens* Weigmann) appear and increase to large numbers about the eighth day when they are evenly distributed over the whole surface. There is little doubt but that these organisms are responsible for the reddish color which appears on the cheese at this time. The slime on the surface then becomes heavier and is about the consistency of soft butter.

From ten to eighteen days the yeast cells tend to decrease in size, become distorted and disappear entirely. Very few yeast cells were to be found on the older cheeses.

Other types of microorganisms, though present from time to time, do not appear to have any important part in the ripening of the limburger cheeses.

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WATER SOLUBLE CARBOHYDRATES IN FORAGE CROPS AND THEIR RELATION TO THE PRODUCTION OF SILAGE

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There are two outstanding classes of forage crops that are extensively grown on New York farms. These may be conveniently designated as non-legumes and legumes. Under certain conditions both of these can be converted into silage. Such crops as corn, millet and sorghum which are in the non-leguminous class have been used as silage crops for many decades. Little difficulty is ever encountered in obtaining a good product from these crops. Attempts to produce silage from such crops as alfalfa, red or alsike clover and soybeans, which are in the leguminous class, have usually resulted in a product that is not palatable. In a majority of cases the product is returned to the land as a fertilizer.

The extensive increase in leguminous forage crop production for animal feed, both in kind and quantity, has prompted requests for methods of preserving these crops. Other weather conditions retard or prevent the process of haymaking. In a large number of instances the cut material spoils or the hay produced from it is of such an inferior quality that animals refuse most of it. In a few cases a certain quantity of a legume crop may be ensiled with a larger quantity of a non-legume and an acceptable silage produced. Often, however, the legume and the non-legume cannot be harvested at the same time. Other difficulties may arise so that other methods than making a mixed silage have to be practiced in handling these crops.

STATEMENT OF PROBLEM

One of the principal reasons for the numerous failures in the making of silage from legumes was presented by Wilson (4) in an article that dealt with the neutralizing power of forage crops for organic and mineral acids. He pointed out that leguminous materials require more organic or mineral acid to reduce their pH one unit than is required by a similar quantity of a non-leguminous material. He reemphasized also that legume forage crops may be deficient in acid-producing carbohydrates. If the latter were true these two characteristics of the legumes may explain the numerous failures in efforts to produce silage from such highly nitrogenous crops. This paper, therefore, presents analyses of the water-soluble carbohydrates of both legumes and non-legumes and their relation to the production of silage.

Several investigators have suggested that there should be a high ratio between the fermentable carbohydrates and the other materials such as nitrogen before good silage can be expected. Other workers have concluded

that the content of fermentable carbohydrates is sufficient to produce the proper degree of acidity in the silage from any green crop, barring a few exceptional cases, and that the only other chemical qualification necessary to a succulent silage is the proper moisture content. However, with such information available there are too many failures in silage making. It is hoped that the data presented will give a better understanding of why it is difficult to produce silage from leguminous forage crops.

<div align="center">METHODS</div>

Due to the possible rapid conversion of soluble carbohydrates of plant tissues into starch, it was desirable to collect samples of plants growing in the field and start the determinations as soon thereafter as possible. Accordingly, in making determinations of soluble carbohydrates, the freshly cut material was taken immediately to the laboratory and the analysis started. The plants were chopped and carefully mixed (so that a sample of the chopped material would represent the entire crop.) From this chopped tissue duplicate portions of about 50 grams each were taken One was placed in a drying oven at 100° C. This was used to determine the moisture in the sample. The other was placed in a 400 ml. beaker and 200 ml. of water added. The beaker was covered and placed in an Arnold steamer for about 15 minutes. After this heating the sample was allowed to stand over night, if possible, otherwise 4 or 5 hours. The liquid was decanted and a 100 ml. aliquot used. A saturated solution of basic lead acetate was added to this aliquot until no more flocculation occurred. The precipitate was removed by filtration and washed with cold water. Sodium oxalate crystals were added to the filtrate and the solution filtered into a 250 ml. volumetric flask. To the solution in this flask was added 25 ml. concentrated HCl and the mixture allowed to stand over night or heated at 68–70° C. for 10 minutes and cooled. This was necessary in order to hydrolyze polysaccharides to reducing sugars. After hydrolysis by either method, a 40 ml. aliquot was placed in a centrifuge tube. The HCl in the aliquot was neutralized with 25% NaOH using methyl red as an indicator. A volume of Fehling's solution, modified according to Schaeffer (2), equal to the volume of the aliquot was added to the liquid in the centrifuge tube. This was mixed in the tube and the latter placed in a bath of boiling water for exactly 10 minutes. The tube was then transferred to a centrifuge and whirled for at least four minutes. This threw the copper precipitate to the bottom and the supernatant liquid was decanted off. Water was added to the tube and the liquid was again whirled. The water was poured off and the precipitate dissolved in about 10 drops of concentrated HNO_3. For purposes of comparison a dark blue color was then developed by adding a 1–5 solution of NH_4OH. The blue colored liquid was made to a definite volume and compared with that of a standard prepared according to

Schaffer. The quantity of copper was then calculated and the quantity of sugar present calculated from the reduced copper.

This method of determining the water-soluble carbohydrates was compared with the alcoholic extraction method of separating the sugars from interfering substances. Eight comparisons were made. Five of these were with legume forage crops and three were with non-legume forage crops. In every instance the alcoholic extraction method gave a lower percentage of reducing sugars. The difference was not large in any comparison and the average difference was less than four-tenths of one per cent.

Calculating the data:—When forage crops are taken for silage purposes they contain a relatively high percentage of water. This ranges usually from 65 to 85 per cent, with a majority being near 80. With such variations it was difficult to make comparisons of the water-soluble carbohydrates. It was advisable to find a common basis for comparison. Since the water-soluble carbohydrates disappear by being converted in the silo into organic acids which remain in solution and preserve the material, a comparison of these carbohydrates at a uniform percentage of moisture seemed feasible. Therefore, in addition to showing the percentage of these carbohydrates in the dry matter or in the freshly cut material they are shown in the tables also on a basis of 80 per cent moisture. This makes it convenient to compare water soluble carbohydrates of one legume with another or with a non-legume.

Effect of Time of Day on Content of Water Soluble Carbohydrates:— It was recognized that in the daytime carbohydrates may be synthesized more rapidly than they are utilized and that these may be transported or disappear somewhat during the night. If this is true samples of growing plants may have a varying content of water-soluble carbohydrates throughout the daytime. This might necessitate a definite time of day for collecting samples if comparative data are to be obtained. In order to see how much difference there might be, samples of alfalfa and of rye were collected at intervals of 2 hours. The first sample was taken at 4:40 A.M., just at sunrise, and the 7th at 4:40 P.M. The entire day was cloudless. The data are presented in Table 1.

The data show that the percentage of water-soluble carbohydrates in alfalfa from early morning to mid-afternoon remains almost constant. If the results are calculated to a uniform moisture content, say 80 per cent, then at 4:40 A.M. the percentage was 2.17 and it never went above 2.27. At 8:40 A.M. it was just above 2 per cent. The results with rye, through showing about 3 times as much water-soluble carbohydrates as was found in alfalfa, are also fairly uniform. At 4:40 A.M. it was 6.66 per cent and never exceeded 7.9 per cent throughout the day. This is a spread of less than 1.25 per cent.

TABLE 1

Effect of time of day on the percentage of water soluble carbohydrates

July 1, 1935

| TIME OF DAY | ALFALFA (*Medicago sativa*) | | | | | RYE (*Secale cereale*) | | | | |
| | PER CENT WATER | Per cent water soluble carbohydrates calculated on basis of | | | | PER CENT WATER | Per cent water soluble carbohydrates calculated on basis of | | | |
		Sap	Dry wt	Fresh cut	80 per cent moisture		Sap	Dry wt	Fresh cut	80 per cent moisture
A.M. 4:40	73.0	2.38	6.20	1.74	2.17	65.0	8.20	15.23	5.33	6 66
6:40	70.9	2.57	6 26	1.82	2.28	64.8	7.53	13 86	4.88	6.10
8:40	67.1	2.42	4.93	1.62	2.03	60.6	8.53	13.12	5.17	6.45
10:40	58.5	3.06	6.24	2.05	2.24	57.3	9.89	13.26	5.66	7.08
P.M. 12:40	67.4	2.69	5.54	1.81	2.27	60.6	10.43	16.06	6.32	7.90
2:40	67.6	2.58	5.38	1.74	2.18	59.8	10.09	15.01	6.03	7.54
4:40	67.9	2.55	5.39	1.73	2.16	60.2	9.75	14.75	5.87	7.34

It is concluded that the water-soluble carbohydrates of leguminous plant tissue remain rather uniform throughout the day and that they may increase as much as 1.25 per cent from early morning to midday in the non-legumes. It is doubtful whether this variation carries any significance in silage making. However, since this variation may occur, all samples for analysis were collected around midday.

Effect of stage of maturity on the percentage of water-soluble carbohydrates:—Since large quantities of carbohydrates are used in young growing plants it might be suspected that such plants would have a lower percentage of water-soluble carbohydrates than plants actually setting seed. Data bearing out this suggestion are given in Table 2.

It is evident that the sugar content of the less mature tissue is significantly lower than that of the more mature tissue. This is true in 16 of 17 observations. The only apparent exception is the comparison of orchard grass taken when it was setting seed and when the seed was ripe. It might be suspected in this case that plants bearing ripe seed would contain less soluble carbohydrates than when setting seed.

It is concluded from the data presented in Table 2 that the stage of maturity of the plants which are taken for an analysis of their water-soluble carbohydrates should be carefully noted.

WATER-SOLUBLE CARBOHYDRATES IN FORAGE CROPS

It was desirable in this study of the water-soluble carbohydrates in forage materials to have analyses of tissues of plants that may or may not be grown as farm crops. Such analyses lend perspective to the results and aid in their interpretation. Accordingly analyses of many plants, representing legumes and non-legumes, some commonly regarded as weeds and usually found on cultivated lands, were made. Since the stage of maturity of the plants influences the quantity of soluble carbohydrates, plant tissue was collected which was sufficiently mature that it might be used for silage making. For convenience of presentation that data are divided into two groups.

Water-soluble carbohydrates in non-legumes:—It will be noted in Table 3 that the date on which the plant tissue was taken is given. This together with the percentage of moisture and the remarks concerning the stage of maturity of the plant gives a fair idea of the succulence or maturity of the material.

Table 3 reveals that numerous non-legumes such as barley, brome grass, corn, crested wheat grass, hard fescue, Italian rye grass, Kentucky blue grass, perennial rye grass, quack grass, rye, sorghum, sudan grass, timothy, and wheat possess a higher water-soluble carbohydrate content than the remaining plants listed in the table. If the quantity of these carbohydrates is expressed as percentage of water in the forage material, this being cal-

TABLE 2

Effect of stage of maturity on the percentage of water-soluble carbohydrates

PLANT TISSUE	STATE OF GROWTH	PER CENT WATER	PERCENTAGE WATER-SOLUBLE CARBOHYDRATES CALCULATED ON BASIS OF			
			Sap	Dry weight	Fresh cut	80 per cent moisture
Alfalfa (*Medicago sativa*)	Before bloom	75.2	1.02	3.10	0.77	0.96
	Beginning to bloom	74.5	1.46	4.26	1.09	1.35
Artichoke (*Helianthus tuberosus*)	Three feet tall	89.5	0.26	2.25	0.24	0.29
	Six feet tall	80.93	2.82	11.93	2.28	2.85
Barley (*Hordeum vulgare*)	Heads just showing	80.7	1.92	7.99	1.54	1.94
	In head	78.7	3.10	11.06	2.42	3.05
Canada blue (*Poa compressa*)	Late flower	66.8	3.03	6.07	2.03	2.53
	Early seed	65.2	3.17	5.94	2.07	2.58
Clover, red (*Trifolium pratense*)	In bloom	75.9	1.81	5.72	1.38	1.72
	Beginning to seed	76.2	3.10	9.92	2.36	2.95
Corn (*Zea mays*)	3 to 4 feet tall	85.4	2.08	12.70	1.77	2.22
	In milk stage	77.64	5.85	20.25	4.54	5.68
Lotus (*Lotus corniculata*)	In bloom	83.4	0.54	2.71	0.45	0.56
	Setting seed	77.5	2.37	8.16	1.83	2.30
Grass pea (*Lathyrus sativus*)	Before bloom	84.3	0.43	2.29	0.36	0.45
	Setting seed	76.1	1.41	4.49	1.07	1.33
Millet (*Chaetochloa italica* var.)	Heads appearing	84.6	0.36	1.99	0.31	0.38
	In seed	70.4	1.99	4.75	1.15	1.75
Orchard grass (*Dactylis glomerata*)	Setting seed	70.0	2.91	6.00	2.04	2.55
	Seed ripe	75.0	1.66	4.98	1.24	1.56

TABLE 2.—Continued

Effect of stage of maturity on the percentage of water soluble carbohydrates

PLANT TISSUE	STATE OF GROWTH	PER CENT WATER	PERCENTAGE WATER-SOLUBLE CARBOHYDRATES CALCULATED ON BASIS OF			
			Sap	Dry weight	Fresh cut	80 per cent moisture
Peas (*Pisum sativum*)	Before blooming	93.9	0.72	3.77	0.60	0.75
	In full bloom	92.7	1.98	9.46	1.64	1.70
Perennial rye grass (*Lolium perenne*)	In bloom	76.6	3.12	10.21	2.39	2.99
	1 week later	65.1	4.69	8.15	3.05	3.82
Rye (*Secale cereale*)	Blooming	74.5	2.07	6.04	1.54	1.93
	Seed in dough	58.8	9.26	13.21	5.44	6.81
Sainfoin (*Onobrychis viciaefolia*)	In bloom	41.9	1.28	5.90	1.05	1.31
	In seed	71.3	2.80	6.96	1.99	2.49
Sheep's fescue (*Festuca ovina*)	After blooming	79.2	3.03	10.87	2.36	2.96
	1 week later	54.9	7.18	8.74	3.95	4.93
Soybean (*Soja max*)	Pods formed	78.2	0.59	2.13	0.46	0.58
	Pods mature	71.0	2.11	5.16	1.49	1.87
Sunflower (*Helianthus annuus*)	2 feet high	87.5	0.68	4.76	0.39	0.74
	Blooming	82.9	2.29	11.03	1.87	2.37
Timothy (*Phaleum pratense*)	Heading	75.1	2.10	6.34	1.58	1.97
	Blooming	71.7	3.13	7.93	2.24	2.80
Vetch (Kidney) (*Anthyllis vulneraria*)	Early bloom	81.8	1.17	5.23	0.96	1.20
	In full bloom	71.1	1.93	4.74	1.37	1.71
Wheat (*Triticum vulgare*)	At bloom time	76.5	4.70	15.50	3.61	4.51
	Seed well formed	62.3	7.82	12.92	4.87	6.09

TABLE 3

Percentage of water-soluble carbohydrates in non-leguminous forage crops

PLANT TISSUE	DATE	PER CENT WATER	PER CENT WATER SOLUBLE CARBOHYDRATES CALCULATED ON BASIS OF				REMARKS
			Sap	Dry matter	Fresh cut	80 per cent moisture	
Artichoke (*Helianthus tuberosus*)	8/26	80.9	2.82	11.93	2.28	2.85	No bloom, 6 feet tall
Barley (*Hordeum vulgare*)	7/11	78.7	3.10	11.06	2.42	3.05	Heading
Bent grass (*Agrostis tinuis*)	6/21	78.3	0.95	3.45	0.75	0.92	Before blooming
Brome grass (*Bromus inermis*)	6/21	69.3	3.81	8.60	2.64	3.30	Heading; no pollen
Barnyard grass (*Panicum Crus galli*)	8/5	83.8	1.44	7.43	1.21	1.51	Seed already formed
Buckwheat (*Fagopyrum esculentum*)	8/5	86.6	0.95	6.16	0.83	1.03	In bloom
Broom corn (*Sorghum vulgare* var.)	8/26	69.0	3.56	5.61	2.46	3.07	Pollen present
Brotex (*Lavatera* spp.)	8/26	80.6	1.99	8.94	1.63	2.00	Before blooming
Canada blue grass (*Poa compressa*)	6/25	65.2	3.17	5.94	2.07	2.58	Early seed stage
Canada thistle (*Cirsium arvense*)	7/6	82.0	0.58	2.65	0.48	0.59	About to bloom
Chick weed (*Stellaria media*)	7/6	85.1	0.17	0.97	0.14	1.81	In bloom and seed
Chicory (*Cichorium intybus*)	7/6	63.6	0.86	1.50	0.55	0.68	In full bloom
Corn: agr. sel. (*Zea mays*)	8/26	77.6	5.85	20.25	4.54	5.67	In milk stage
sweet (*Zea mays* var.)	8/26	81.7	6.39	28.60	5.23	6.52	Ears ready for market
Creeping red fescue (*Festuca* spp.)	6/28	75.0	1.66	4.98	1.24	1.56	In bloom
Chess (*Bromus secalinus*)	6/21	72.3	4.36	11.37	3.15	3.94	Full heads, no pollen
Crested wheat grass (*Agropyron cristatum*)	6/21	66.5	3.89	7.73	2.59	3.23	Beginning to head
Dandelion (*Taraxacum officinale*)	7/6	80.6	1.03	4.69	0.91	1.04	After seeding, second growth
Daisy (*Chrysanthemum leucanthemum*)	6/24	83.9	2.12	11.05	1.78	2.22	Full bloom
Fescue (*Festuca rubra* var. *arenaria*)	6/28	54.9	7.18	8.74	3.95	4.93	Setting seed
Flax (*Linum usitatissimum*)	7/19	78.7	1.12	4.14	0.88	1.10	Beginning to bloom
Hard fescue (*Festuca duruscula*)	6/28	62.2	4.67	7.68	2.96	3.63	In seed
Hemp (*Cannabis sativa*)	7/19	79.6	1.58	6.16	1.26	1.57	About 3 feet high
Italian rye grass (*Lolium Italicum*)	6/28	62.9	7.22	12.24	4.54	5.68	Beginning to seed
Kentucky blue grass (*Poa pratensis*)	6/14	55.6	4.62	5.79	2.57	3.21	In seed
Millet:							
common (*Chaetochloa italica* var.)	8/26	70.45	1.99	4.75	1.15	1.75	In seed
Early Fortune (*Panicum miliaceum* var.)	7/23	87.3	0.425	2.92	0.37	0.46	In head, before blooming

TABLE 3.—*Continued*

Percentage of water-soluble carbohydrates in non-leguminous forage crops

PLANT TISSUE	DATE	PER CENT WATER	PER CENT WATER-SOLUBLE CARBOHYDRATES CALCULATED ON BASIS OF				REMARKS
			Sap	Dry matter	Fresh cut	80 per cent moisture	
Miller:							
German (*Panicum miliaceum*)	8/26	77.1	2.63	8.83	2.02	2.53	Late flowering
Japanese (*Echinochloa frumentacea*)	8/26	69.0	3.45	7.66	2.38	2.97	In seed
Meadow fescue (*Festuca elatior*)	6/21	73.6	2.73	7.61	2.01	2.51	Seed forming
Meadow foxtail (*Alopecurus pratensis*)	6/21	69.4	1.89	4.28	1.31	1.64	Headed but no pollen
Mustard (*Brassica sinapistrum*)	7/6	87.9	0.65	4.72	0.57	0.71	Full bloom
Orchard grass (*Dactylis glomerata*)	6/17	70.0	2.91	6.80	2.04	2.55	Setting seed
Oats (*Avena sativa*)	7/6	76.1	3.12	9.93	2.37	2.97	Heading
Perennial rye grass (*Lolium pirenne*)	6/28	65.1	4.69	8.15	3.05	3.82	In bloom
Plantain (narrow leaf) (*Plantago lanceolata*)	6/17	80.3	2.56	10.40	2.06	2.57	Flowering
Quack grass (*Agropyron repens*)	6/25	66.0	5.40	10.48	3.56	4.45	Blooming
Rye (*Secale cereale*)	6/25	58.8	9.26	13.21	5.44	6.81	Setting seed
Rape (*Brassica campestris*)	7/19	87.8	1.12	8.06	0.98	1.23	
Rough-stalked meadow grass (*Poa trivialis*)	6/28	58.9	2.92	4.18	1.72	2.15	In seed
Sheep's fescue (*Festuca ovina*)	6/21	78.2	3.03	10.87	2.36	2.96	After blooming
Sesame (*Sesame Indicum*)	8/26	84.5	1.36	7.43	1.15	1.44	In bloom
Sorghum vulgare	8/26	91.3	4.08	17.79	3.32	4.15	Pollen present
Sudan grass	8/26	70.4	5.63	13.41	3.97	4.95	Seed-milk stage
Sunflower (*Helianthus annuus*)	8/26	82.8	2.29	11.03	1.89	2.37	Full bloom
Summer foxtail (*Setaria glauca*)	7/19	96.7	0.67	4.37	0.58	0.73	Heads just appearing
Sweet vernal grass (*Anthroxanthum odoratum*)	6/17	60.2	2.74	4.14	1.65	2.06	Late flowering stage
Teosinte (*Euchlaena mexicana*)	8/5	89.6	0.95	7.00	0.72	1.06	
Timothy (*Phleum pratense*)	6/14	70.3	4.71	8.32	2.48	4.14	Prior to blooming
" (pasture)(*Phleum pratense* var.)	6/28	78.5	2.99	10.92	2.35	2.93	
Velvet grass (*Holcus lanatus*)	6/28	67.4	2.22	4.59	1.50	1.87	In seed
Wheat (*Triticum vulgare*)	6/25	62.3	7.82	12.92	4.87	6.09	Setting seet
Yarrow (*Achillea millefiora*)	6/28	85.9	1.09	5.64	0.94	1.17	Blooming

culated for each sample to a uniform moisture basis of 80 per cent, it is clear that all the above-mentioned crops possess more than 3 per cent of water-soluble carbohydrates, the two highest being rye with 6.71 and sweet corn with 6.52 per cent.   At least a dozen other non-legumes that are grown or may get into the silo also possess a content of water-soluble carbohydrates of 2 to 3 per cent.   In this group are Canada blue grass, oats, plantain, sunflower and timothy.   Of lesser interest from the standpoint of silage making but of value in relation to the other data are the water-soluble carbohydrates of many other plants.   In this group are such plants as barnyard grass, buckwheat, Canada thistle, chicory, dandelion, flax, hemp, mustard, plantain, rape, velvet grass, and yarrow.   These possess less than one per cent of soluble carbohydrates.

Water-soluble carbohydrates in legumes:- The data relating to the water-soluble carbohydrates in legumes are presented in Table 4.   For purposes of comparison they are calculated on a basis similar to those shown in Table 3.   Only 7 of the 31 legumes examined possessed a water soluble carbohydrate content of 2 per cent or over.   Vetch was the highest with 3.34 per cent.   The next highest was red clover with 2.95 per cent.   Beans, chick pea, lespedeza and lupine possessed less than 1 per cent of these carbohydrates.

PRACTICAL APPLICATION OF THE FINDINGS

It is concluded from the analytical data concerning the water-soluble carbohydrates of forage crops that one of the main reasons why legumes do not ensile satisfactorily is the small quantity of sugar in their tissues.   This has been suggested by several workers, notably Reed and Fitch (1) of Kansas, but few if any data comparing legumes and non-legumes have been presented by such workers to substantiate their suggestion.   This conclusion is also reached from the data presented in this paper because there is approximately three times as much fermentable sugars in the non-legumes that produce acceptable silages as there is in the legumes that produce inferior silages.   This conclusion is also strengthened by the fact that vetch and possibly red clover, which have been the most reliable legumes from which to make silage, have the highest percentages of water soluble carbohydrates of all the legumes analysed.

Influence of the addition of fermentable carbohydrates on the production of silage:—If the failure to produce silage from leguminous tissue is due to a shortage of fermentable carbohydrates it should be possible to supplement them with sugars from other sources and obtain a satisfactory product.   Of course this is what Reed and Fitch (1) did but their applications are too expensive.   To expand our information on this point, and to place the applications on a practical basis, grass clippings were collected and employed in such a test.   The clippings were a mixture of grass with

TABLE 4

Percentage of water-soluble carbohydrates in leguminous forage crops

PLANT TISSUE	DATE	PER CENT WATER	PER CENT WATER-SOLUBLE CARBOHYDRATES CALCULATED ON BASIS OF				REMARKS
			Sap	Dry matter	Fresh weight	80 per cent moisture	
Alfalfa (*Medicago sativa*)	6/14	77.1	1.28	4.32	0.99	1.23	Early silage stage
Anthylis (*Anthyllis vulneraria*)	6/25	74.5	1.46	4.26	1.09	1.36	Beginning to bloom
Apios (*tuberosa*)	7/6	71.1	1.93	4.74	1.37	1.71	In full bloom
Baptisia (*australis*)	7/23	75.8	1.13	3.54	0.86	1.07	Before blooming
Black locust (*Robinia Pseudo-Acacia*)	6/28	77.9	2.11	7.44	1.64	2.05	Pods forming
Black medic (*Medicago lupulina*)	7/11	69.9	1.25	2.89	0.87	1.09	
Beans (*Phaseolus vulgaris*)	6/25	80.2	1.57	6.36	1.25	1.57	Seeds and blossoms
	6/28	75.5	1.37	4.22	1.03	1.29	Seeds and blossoms
Chick pea (*Cicer arietinum*)	8/5	83.4	0.83	4.16	0.69	0.86	Before blooming
	8/5	79.9	0.83	3.32	0.67	0.83	Pods formed
Clover, red (*Trifolium pratense*)	6/25	76.2	3.10	9.92	2.36	2.95	Beginning to seed
alsike (*Trifolium hybridum*)	6/25	79.0	1.38	5.19	1.09	1.36	Beginning to seed
hop (*Trifolium agrarium*)	6/17	73.7	2.03	5.70	1.50	1.87	In full bloom
Hungarian (*Trifolium pannonicum*)	7/6	66.9	2.66	5.39	1.77	2.22	In bloom, beginning to seed
Ladino (*Trifolium repens var. Ladino*)	6/28	79.4	1.51	5.82	1.20	1.50	In full bloom
Late red (*Trifolium pratense var.*)	6/28	79.7	1.80	7.11	1.44	1.79	Before blooming
Sweet (*Melilotus alba*)	6/21	88.0	1.28	6.23	1.06	1.41	Beginning to bloom
White (*Trifolium repens*)	6/21	81.9	0.99	4.47	0.81	1.01	In full bloom
Yellow sweet (*Melilotus officinalis*)	6/28	75.1	2.27	6.85	1.70	2.13	In full bloom
Cowpea (*Vigna sinensis*)	8/26	79.0	1.74	6.55	1.38	1.72	Beginning to bloom
Dalea (*Alopecuroides*)	8/5	75.6	1.56	4.83	1.18	1.47	Before blooming
Hog peanut (*Amphicarpa monoica*)	7/11	80.5	0.62	2.56	4.99	0.62	
Birdsfoot trefoil (*Lotus corniculata*)	6/25	77.5	2.37	8.16	1.83	2.29	Beginning to set seed
Lathyrus sativus	7/6	76.1	1.41	4.49	1.07	1.34	Beginning to set seed
Lespedeza striata	8/5	74.9	0.53	1.58	0.40	0.50	Blooming
Lupine (*Lupinus perennis*)	7/23	84.2	0.85	4.87	0.72	0.89	After seeds were mature
Peanut (*Arachis hypogeae*)	8/26	75.5	1.41	4.33	1.07	1.33	In bloom
Peas (*Pisum sativum*)	7/16	82.7	1.98	9.46	1.64	1.70	In full bloom
Sainfoin (*Onobrychis vicieafolia*)	6/28	71.3	2.80	6.96	1.99	2.49	In seed, a few flowers
Soybean (*Soja max*)		71.0	2.11	5.16	1.49	1.87	Pods mature
Vetch (*Vici villosa*)	6/6	74.9	3.46	10.32	2.59	3.24	In full bloom

legumes as well as of each separately. They were analyzed for their water-soluble carbohydrates and employed to make silages. The water-soluble carbohydrates of the clippings were supplemented with corn sugar. The relation of the carbohydrates in grass clippings and the influence of supplementing these with corn sugar to the quality of the silage are shown in Table 5.

The influence of the clover in the mixture of grass clippings on the percentage of water-soluble carbohydrates is easily observed. In every instance the mixture of legume and non-legume shows a lower percentage of water-soluble carbohydrates than the non-legume. This situation is also reflected in the acidity of the silage made from these clippings as expressed by their pH. In each instance the pH units were smaller if the silages were made from the non-legumes. When silages were made from the clippings after the addition of corn sugar all mixtures made good silages, while without the sugar only those with the higher percentages of sugar produced silages that appeared satisfactory.

The influence of the added sugar on the reaction and quality of the resulting silage suggests that silage might be made from any legume forage crop provided the proper quantity of an acid-producing substance were added to the forage material. Accordingly soybeans were obtained from the field and chopped finely. This cut material was divided into three portions. One portion was used as a control. To another portion was added corn sugar at the rate of 1.5 per cent of the green weight. To a third portion was added 3 per cent corn sugar. Silage was made from each. The silos were filled on September 22 and were emptied on December 15. The control at this time was of a poor quality. The odor was of such a character that it indicated early stages of putrefaction. Water extracts were dark brown. The silage resulting from the addition of 1.5 per cent corn sugar was acceptable. It possessed a good aroma and no signs of putrefaction were evident. The water extract from this silage was almost clear. The silage resulting from the addition of 3 per cent corn sugar was excellent in every particular. The water extract, however, contained a little more color than the extract from the silage made with the addition of 1.5 per cent corn sugar.

Other legumes have been employed in similar attempts. The experiment with green peas is here described. The chopped vines and pods were placed in silos of 60 pounds, capacity. To the chopped material in one silo was added 1.5 per cent corn sugar, to that in another 3 per cent, and to that in a third 5 per cent. A fourth was filled as a control. The cut material remained in the silos four weeks. The resulting product from each was examined. The best silage was produced from the green peas that received 1.5 per cent corn sugar at the time they were packed in the silo. It possessed the best color, odor and firmness. The silage that was made from

TABLE 5

Relation of water soluble carbohydrates in grass clippings to quality of silage

PLAT	PER CENT H₂O	PER CENT WATER SOLUBLE CARBOHYDRATES CALCULATED IN				COMPOSITION OF GRASS	SILAGE			
		Sap	Dry weight	Fresh cut	80 per cent H₂O		pH	Quality	Odor	Remarks
211	82.6	0.89	4.22	0.73	0.92	Kentucky blue grass, wild white clover	5.0	Good	Fair	Too wet
212	76.0	2.34	7.41	1.78	2.22	Kentucky blue grass	4.1	Good	Good	Firm
215	82.9	0.71	3.44	0.59	0.73	Wild white clover	6.6	Fair	Poor	Too wet
226	82.8	0.71	3.42	0.59	0.73	Ayrshire perennial rye grass with white clover	4.8	Fair	Poor	Too wet
227	78.1	1.37	4.89	1.07	1.33	Ayrshire perennial rye grass	4.2	Good	Good	Firm
311	79.7	0.82	3.22	0.65	0.81	Commercial orchard grass, wild white clover	4.9	Fair	Good	Too wet
312	77.1	1.06	3.57	0.82	1.04	Commercial orchard grass	4.5	Good	Good	Too wet
313	78.3	0.76	2.74	0.59	0.74	Stapledon's S.50 Timothy, wild white clover	4.9	Fair	Good	Too wet
319	82.4	0.88	4.12	0.72	0.90	Commercial timothy, wild white clover	4.9	Fair	Good	Too wet
320	76.5	1.76	5.73	1.35	1.67	Commercial timothy	4.2	Good	Good	A little wet
211						Grass with 1½ per cent corn sugar	4.9	Good	Fair	A little wet
211						Grass dried to 73 per cent water	4.9	Good	Fair	Firm
215						Grass with 1½ per cent corn sugar	6.6	Good	Fair	Wet
215						Grass dried to 79 per cent water	5.2	Good	Good	Firm
226						Grass with 1½ per cent corn sugar	4.7	Good	Fair	Wet
226						Grass dried to 74 per cent water	4.9	Good	Fair	Wet
311						Grass with 1½ per cent corn sugar	4.6	Good	Fair	Wet
311						Grass dried to 62 per cent water	4.9	Good	Good	Satisfactory
313						Grass with 1½ per cent corn sugar	4.6	Good	Good	Wet
313						Grass dried to 71 per cent water	4.9	Good	Good	Firm
319						Grass with 1½ per cent corn sugar	4.4	Good	Good	Wet
319						Grass dried to 73 per cent water	4.8	Good	Good	A little wet
320						Grass with 1½ per cent cerelose	4.2	Good	Good	A little wet

the green peas without the addition of sugar was dark, a little soft and of inferior odor, indicating that an undesirable type of fermentation was occurring. The silage resulting from the green peas to which 3 per cent corn sugar was added was also a good product. It was a little bitter to taste but possessed a pleasant odor and a good color. This tendency toward bitterness was pronounced in the silage that was made from the peas to which 5 per cent sugar was added. The color and odor, however, were satisfactory. Apparently nothing was gained by the addition of more than 1 5 per cent sugar to the crop at the time it was packed in the silo.

Satisfactory silage has also been made from numerous other legumes than peas by incorporating with the freshly cut material any readily fermentable carbohydrate that is converted into organic acids. Such substances as glucose, sacchrose, lactose, maltose, and molasses were experimentally employed. These substances that are added for the purpose of increasing the acidity of the silage were applied to forage material in the following percentages: 0.1, 0.3, 0.5, 1, 1.5, 2, 3, and 5. The quality of the resulting silage that was made from the alfalfa to which 1.5 per cent was applied was significantly superior to that produced from alfalfa to which smaller percentages were added. No further increase in the quality of the silage was noticeable with applications larger than 1.5 per cent.

The above information indicates that successful ensiling of legume crops occurred when 1.5 per cent of sugar was added to the crop as it was being packed in the silo. In experiments with alfalfa at Kansas Reed and Fitch (1) added 10 per cent of black strap molasses. Since these experimental silos held only a few pounds it was desirable to test this application of sugar on a larger quantity of material. For this purpose 3-ton silos were available. They were filled with third-cutting alfalfa to which was added, as it went through the silage cutter, about 1.5 per cent corn sugar. The quantity necessary was calculated from the green weight of the crop. A second silo was filled with alfalfa to which was applied 3 per cent corn sugar. These silos were filled on the 4th day of October, 1934.

On the 20th day of November the silo containing alfalfa that was treated when packed with 1.5 per cent corn sugar was opened. Samples were taken for certain tests and the remaining silage fed to cattle. There were no leachings from the silo. From all appearances and tests the silage was unusually good. It possessed an attractive odor, was firm and an acidity of pH 4.5 indicated that sufficient acid had been developed to prevent putrefaction.

The silo that was filled with the alfalfa that was treated with 3 per cent corn sugar was opened after 8 months. The alfalfa had been converted into an excellent silage. An acidity of pH 4.3 indicated that no putrefaction had occurred. The odor was excellent and the silage was also fed to cattle.

Influence of the addition of acids on the production of silage:—It is evident from the results of the experiments just reported that forage crops fail to ferment properly and to produce a high quality silage because they do not contain an ample supply of water-soluble carbohydrates that can be converted into organic acids. Such a condition is made worse by the fact that a larger quantity of acid must be produced in a silo packed with a leguminous crop to insure a satisfactory product than is required in a silo packed with a non-leguminous crop. This is true because leguminous materials have a larger neutralizing power for organic and mineral acids (4) than do the non-leguminous materials. The soluble carbohydrates are converted almost quantitatively under anaerobic conditions in the silo into organic acids. An ample supply of acid-producing substances gives a high quality silage; an insufficient production of organic acids gives an inferior silage.

Since the successful ensiling of forage crops is accompanied by the production of organic acids it should be possible to add acids of one sort or another to freshly cut crops and thus accomplish the same purpose. Success can be obtained by this method. Both organic and mineral acids were employed in such a study. Since the organic acids are weaker than the mineral acids it requires less of the latter to produce the required acidity. Experimentally such acids as hydrochloric, sulphuric, phosphoric, lactic and acetic or combinations of these were employed. They were added either to supplement the acid normally produced by fermentation or in sufficient quantity to reduce the bacterial activity to a minimum. From the experimental standpoint enough of any acid can be used to reduce the pH of the forage material to 4.0. This will reduce bacterial activities to a minimum and produce preservation conditions. If the acid that is added does not produce this condition, fermentation of the water-soluble carbohydrates of the ensiling material will occur and a pleasing odor will be developed simultaneously. From numerous concentrations and combinations that have been tested experimentally in small containers two were selected for trial in 3-ton silos.

Two silos were filled on the 4th day of October with third cutting alfalfa. As the cut material fell into one of the silos equal quantities of 4 normal hydrochloric and sulphur acids were added. The quantity applied was at the rate of 30 liters per ton. This is essentially the formula employed by Vertanen (3) to preserve fresh fodder. When the other silo was being filled there was added to the forage 1.5 per cent corn sugar and 15 liters of a 4 normal hydrochloric acid solution to a ton. Both silos were opened 8 months later and the resulting products examined.

There was no loss of liquid by leaching during this period. The alfalfa that was treated with a mixture of both acids had changed scarcely any. There was a slight odor, indicating that some fermentation had occurred.

The silage was firm and cattle ate it with relish The acidity as recorded by a potentiometer was pH 4.5. The alfalfa that received the hydrochloric acid and sugar was also an excellent product. The acidity expressed in pH units was 4.5. The odor was *plentiful,* indicating that the hydrochloric acid had produced only partial preservation conditions and that fermentation of the water-soluble carbohydrates to organic acids had carried the acidity on to the preservation point.

<div align="center">DISCUSSION</div>

It was shown previously (4) that more acid is required to change the reaction of leguminous tissues one pH unit than is required by non-leguminous tissue. The data presented in this paper show that the water-soluble carbohydrates, or what may be called the fermentable carbohydrates, of leguminous fodders are considerably lower than those of the non-leguminous fodders. Since the ensiling material is preserved by the production of organic acids that are produced from the fementable carbohydrates, these differences between the two types of forage crops are thought to be the reasons why non-legumes ensile without much difficulty while legumes seldom ensile satisfactorily. When they do ensile properly, it is evidence that they contain an ample supply of fermentable carbohydrates.

This deficiency of the leguminous fodders for silage purposes can be overcome. If the fermentable sugars contained in the legumes are supplemented to the extent of 1 5 per cent of the green weight with any fermentable carbohydrate such as sugars or those materials contained in molasses, a desirable type of fermentation occurs with the result that an acceptable silage is produced. Also, acids, either organic or mineral, may be employed to produce either part or all of the acidity needed for preservation purposes.

Silages made by these methods met every test that is expected of a good silage. The employment of an acid or acids that increase the acidity may preserve certain qualities of the freshly cut material that may be lost when the fodder is allowed to ferment spontaneously. If the hydrochloric or suphuric acid is employed for preservation purposes the resulting silage contains an unusual quantity of acidic radicles. These are much in excess of the nutritional requirements of animals. When the silage is eaten these acidic radicles may reduce the alkaline reserve of the blood.

If phosphoric acid is employed it produces preservation conditions for the fodders, increases the quantity of phosphorus available for animal consumption and results in a higher phosphatic fertilizer for spreading on the land. This makes the phosphoric acid do triple duty and spreads the cost of preserving the silage to more than one farm undertaking. It would seem that phosphoric acid migh be recommended for this purpose because many of our soils and the forage crops grown on them are deficient in this constituent.

In localities where phosphoric acid can be obtained at an economical price its use for silage preservation should be encouraged.

SUMMARY

Leguminous and non-leguminous plants were collected and were analyzed for their water-soluble carbohydrates. Plants of different stages of maturity were collected. They were taken around midday and the analysis started immediately. The tabulated results show the percentages of fermentable carbohydrates in the sap of the plant, in the fresh and dry weight of the plant and in the moisture calculated for each sample to a uniform basis of 80 per cent. Notes that might have some bearing on the production of silage from these crops were made.

The wide difference in the water-soluble carbohydrates of these two types of forage crops suggested that the legumes are deficient in fermentable carbohydrates and thus fail to produce a silage of satisfactory quality.

Acting on this suggestion, silages were made by supplementing the fermentable sugars in the legumes with such substances as corn sugar and molasses. Since these carbohydrates are converted into organic acids both organic and mineral acids were also employed to reduce the pH of the freshly cut material to a point which reduced materially the microbial activity. It was found that silages of superior quality could be made by these methods. In the discussion it was suggested that phosphoric acid might be employed profitably to preserve the fodders; to increase the phosphorus content for animals and to increase the fertilizing value of the farm manure.

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THE OXIDATION OF BUTTERFAT

II. THE COMPOSITION OF THE FAT IN RELATION TO ITS SUSCEPTIBILITY TOWARD OXIDATION*

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A tallowy or oxidized flavor in the milk herds where utmost precautions have been taken to produce clean milk and to protect it from light and metal contamination is often traceable to the milk from one or more cows. Trouble with this off-flavor frequently occurs spasmodically, appearing for a time and then disappearing for no apparent reason. These observations suggest that the difference in the susceptibility of the fat toward oxidation is probably to be found in the composition of the fat.

REVIEW OF LITERATURE

Of 155 cows, representing 5 herds, Guthrie and Brueckner (1) found that 21 per cent gave milk that showed distinctly oxidized flavors, and an additional 10 per cent produced milk which developed a slight oxidized flavor. Except in a few cases, there was no regularity as to which cows would produce milk subject to the development of oxidized flavors.

Chilson (2) reported 25 to 30 per cent of the cows of the Cornell College herd as giving milk during the winter and spring months which developed an oxidized flavor.

Roadhouse and Henderson (3) state that an average of 24.2 per cent of the 349 milk samples entered at the California State Fairs from 1930 to 1934 were criticized as having an oxidized flavor.

The only indication found by Guthrie and Brueckner (1) that there was any relation between the feed of the cow and the production of milk capable of the development of the oxidized flavors was the tendency of most cows that produced milk which acquired these flavors in winter not to produce such milk in summer. These investigators concluded that the dry feeds were not the sole cause of the development of these flavors inasmuch as there was a variation in the intensity of the oxidized flavors developed in the milk from different quarters of the same udder.

Majer (4) claims that the tallowy flavor in the butterfat of milk comes from the feeding of overheated industrial residues and of residues of the sugar industry.

Kende (5) found that milks of different origins varied in their susceptibility toward tallowy development. This investigator believes that milk contains hitherto unknown organic compounds of complicated composition (reductases) which, depending particularly on the quality of the feed which is given the cow, are contained in the milk in quantities more or less large and which naturally protect the milk from developing oxidized flavors. If these protecting substances are lacking, the milk is extremely sensitive to the action of metals.

Tracy and Ruehe (6) pointed out that tallowiness in market milk is more common in winter than in summer. In a later publication (7) these investigators reported that there was a great variation in the tendency of different milks produced under the same conditions to develop a tallowy flavor which could not be correlated with the percentage of fat present in the milk. They suggest that milks may contain reducing bodies other than bacteria, such as leucocytes, that are a factor in retarding oxidation of the butterfat.

Henderson and Roadhouse (8) report that cows showed differences in the stability of their fat when maintained on the same ration. They found that three cows produced a more stable fat when maintained on an oat hay ration than when alfalfa hay was fed. There was no significant difference in the rate of oxidation of the fat when animals were maintained on the dry and green alfalfa regimes. The samples of fat produced by the cows receiving alfalfa hay contained approximately 36 per cent less carotene than when green alfalfa was fed and oat hay 41 per cent less carotene.

Dahle (9) suggests that feed may have something to do with the tallowy flavor in milk, since it usually disappears in the summer when the cows are on pasture.

Anderson, Hardenbergh and Wilson (24) have made observations which lead them to believe that off-flavored milk from individual cows might be caused by dietary deficiencies.

Guthrie and Brueckner (1) could find no relation between the breed, period of lactation, or age of the cow and the development of the oxidized flavors in the milk.

Lea (10) found that a sample of beef kidney fat with an iodine number of 42.51 was more susceptible to oxidation as measured by peroxide formation and Kreis reaction than a sample of fat with an iodine number of 40.25.

Eckles and Palmer (11) have shown that overfeeding of the cow caused a decrease in the iodine number of the fat, while underfeeding, by which the cow was in a negative nutritional balance, caused an increase in the iodine number.

Henderson and Roadhouse (12) found that the fat from the milk produced from animals drawing upon their body fat by consumption of sub-maintenance rations showed increases in the percentage of unsaturated fats and increased susceptibility of the fat to oxidation.

Kenneth and Hilditch (13) report an abrupt increase in oleic and linoleic acids when cows go on pasture and a gradual increase in the amount of unsaturated fat as cows age.

Although Hunziker, Mills and Spitzer (14) have shown that feeding cows rations high in linseed oil meal or cottonseed meal will greatly increase the iodine number of the fat, Frazier (15) was unable to determine any difference in the development of a tallowy flavor in the milk of cows fed such rations.

In their work with shortenings for crackers Triebold and Bailey (16) state, ''The data indicate that there is no uniform relationship between the iodine number and the keeping qualities (resistance to oxidation) of a shortening. Restricting the comparison to one type of shortening, presumably containing the same unsaturated glycerides, it appears that there is a slight tendency for those samples having the lower iodine number to have the better keeping qualities.''

Ruemele (28) has shown that linolenic and linoleic acids oxidize before oleic acid in a reaction mixture containing the three acids. Oleic acid became rancid after absorbing a very small amount of oxygen while the linoleic acid first became rancid after absorbing a considerable amount of oxygen and the linolenic acid did not become rancid on oxidation. This investigator found that a sample of fat containing a large proportion of highly unsaturated acids had to be oxidized to a higher peroxide value and Kreis value in order to develop a rancid flavor than if the fat contained principally oleic acid. At elevated temperatures the decomposition of the more unsaturated product was very rapid and a much lower peroxide value occurred with a rancid flavor than when oxidized at lower temperatures. The action of heat on the flavor and odor development in methyloleate occurred in a much smaller degree than in the product containing linoleic acid.

EXPERIMENTAL PROCEDURE

In these trials, milk from individual cows of the University herd was secured, separated and churned with due regard to the prevention of metal contamination. The various tests reported in this paper were made on the butter oil after the butter had been melted and filtered.

The stability of the butterfat toward oxidation was measured by an accelerated peroxide test. The apparatus used is shown in Figure 1 and is essentially the same as that devised in the Swift Laboratories (17) except for some adaptations added by the authors (18). The peroxide number was determined according to the method proposed by Wheeler (19). The Wheeler test was carried out by gently rotating for 1 minute a 250 cc. extraction flask containing approximately 5 grams of melted butterfat in 50 cc. of a 1:2 mixture of chloroform-glacial acetic acid to which 1 cc. of saturated potassium iodide (freshly prepared) had been added. Fifty cubic centi-
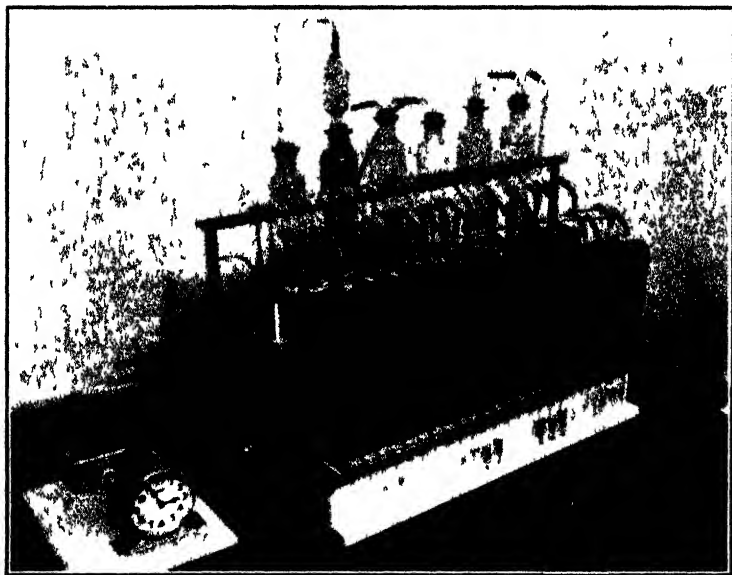
Fig 1   Apparatus Used for Measuring the Stability of Butterfat
Toward Oxidation

meters of water were then added and the liberated iodine titrated with stand-
ard sodium thiosulphate solution   The results are expressed as ''peroxide
number'' or ''peroxide value'' which may be defined as the number of milli-
mols of active or peroxide oxygen in combination with one kilogram of oil
or fat

In making stability tests three 20 cc. samples of the same butterfat were
placed in the oxidation apparatus in succession at hourly intervals and the
approximate end of the induction period determined by absorbing the vola-
tile acids carried over by the aeration in an alkaline solution containing 1 cc
of N/100 sodium hydroxide.   The indicator used was methyl red and when
it changed from yellow to red in the first of the three tubes, it indicated that
the sample of fat was beyond the end of the induction period and had a
peroxide number greater than 10   Since the other two samples had been in
the apparatus for a shorter period (one and two hours less, respectively)
they were still in the induction period or nearing the end.   All three samples
were removed at this point and analyzed for peroxides.   It was found neces-
sary to use great care in cleaning the glassware which came in contact with
the fat in making stability tests.   Best results were obtained by thoroughly
washing the tubes and soaking them in cleaning solution over night, followed
by leaching in several changes of distilled water over a period of three to
four days.

The stability value of butterfat as used in this paper is defined as the number of hours required to oxidize 20 cc. of butteroil at 100° C. to a peroxide value of 10, when air is bubbled through the fat at the rate of 2.33 cc. per second. The peroxide value of 10 was selected as an arbitrary value indicating the end of the induction period and marking the beginning of the period of rapid peroxide formation (23). A high stability value indicates a good keeping quality fat and vice versa.

The color of the fat was determined by comparison with standard solutions of potassium dichromate and is expressed as the number of millimols of potassium dichromate per liter of solution.

The refractive index of the fat was measured with a Zeiss butyro-refractometer at 40° C.

The iodine numbers were determined according to the Hanus method.

The thiocyanogen-iodine number was determined according to the directions given by Jamieson (20) except that 0.5 gram of fat and 50 cc. of the thiocyanogen solution were used. It was found that in the case of butterfat these larger amounts of fat and thiocyanogen solution gave better results. These findings are in accord with those of Wiley and Gill (21) who recommend 0.4 gram samples and 50 cc. of the thiocyanogen solution.

The percentages of free fatty acids were calculated according to the following formulae:

(X) Per cent linoleic acid = 1.104 (I. No. – SCN No.)

(Y) Per cent oleic acid = 1.112 (2 SCN No. – I. No.)

Per cent saturated acids + unsaponifiable matter = 95.7 – (X + Y)

In view of the findings of Bosworth and Brown (22), in which they report that their attempts to verify the occurrence of ordinary lionleic acid failed but that they found other acids with two double bonds and also highly unsaturated acids of the arachidonic type, these calculations are probably not exact but serve to indicate in a comparative way the amounts of acids with unsaturation greater than oleic acid.

EXPERIMENTAL RESULTS

A. *The Stability of Creamery Butter*

In order to obtain some idea of what could be expected as to the stability value of butterfat, a number of butter samples sent to the University Dairy Department from various creameries for scoring, as well as the butter from the University Creamery, were tested. The stability values as well as the scores of the butter are given in Table 1. As might be expected there was no direct correlation between the score and the stability value, however, it is of interest to note that the lowest scoring sample had the lowest stability value.

TABLE 1

Stability value of various samples of creamery butter

SAMPLE	SCORE	STABILITY VALUE
University creamery		20½
University creamery		19
216	86	8
213	90	21
209	89½	18
207	92½	20½
210 ..	91½	18
212	90½	20
214	90½	19
211	92	14
208	92	14

From these results it appears that fresh creamery butter has a stability value of approximately 20.

B. *Effect of Breed and Individuality of the Cow*

Samples of milk were obtained from a number of cows of the University herd while the cows were all receiving the same winter ration. The ration was quite characteristic of the average Wisconsin dairy herd ration and is given at the bottom of Table 2.

There appears to be a great deal of variation between the individual cows of the same breed and from breed to breed. With the small number of cows tested averages have but little value, but it seems quite definite that in general the milk fat from the Holstein cows on winter rations was more susceptible to oxidation than that from the other breeds. The milk fat from most of the Guernsey cows had an exceptionally high stability value, one as high as 54½.

No opportunity was afforded at the time to check the stability of the fat from day to day as the ration of most of the cows was changed shortly after the first samples were obtained. However, two of these cows, M87 and Lotus, were kept on winter rations and their fat was again tested after about an interval of one month. The fat of M87 showed stability values of 29½ and 15 respectively and that of Lotus 36 and 40½. These values would seem to indicate that the stability of the fat is subject to variations even though the cow is kept on the same ration.

C. *Effect of Feed*

Grass ration.—When the cows were placed on a summer ration where grass replaced the alfalfa hay and the oil meal was omitted from the grain ration, the stability values dropped in all cases except two (see Table 2, cows 67 and Fuschia) and in these two cases the values obtained for the fat on the

TABLE 2
Effect of breed and individuality of cow

BREED	COW	WINTER RATION	SUMMER RATION
		stability value	*stability value*
Holstein	65	42	24
	67	19½	26½
	68	30½	24½
	M 87	29½	
	Average	30.4	25
Guernsey	404	51	38
	432	42½	17½
	433	31	24½
	435	41½	25½
	436	54½	22
	Fawn	42	26
	Average	43.7	25.7
Ayrshire	Janice	47½	29½
	Quintilla	52	30
	Lass	18	17½
	Average	39.2	25.6
Brown Swiss	Fuschia	22½	27
	Fidelity	48	27
	Dora	46½	20½
	Average	39.0	24.8
Jersey	Lotus	36	

Herd Rations

Winter ration:
Alfalfa hay
Corn silage
Grain:
   500 corn and cob
   200 oats
   100 oil meal
   200 bran

Summer ration:
Grass
Corn silage—1 feed
Grain:
   700 corn and cob
   200 bran
   100 oats

winter ration seem to be low as compared to those of the other cows. When the averages of the cows in the various breeds are compared on summer ration the values are so close that it may be concluded that there is no difference.

A. I. V. silage ration.—The fat from another group of cows on A. I. V. silage experiments as well as the check cows was tested for stability. The results are shown in Table 3. Two cows from each lot were later turned out on grass. The fat from three of the A. I. V. silage cows showed excellent keeping qualities while the fat from one cow, M86 (Holstein), stood up for only 6 hours. A later test (about 1 month) while the cow was on the same

TABLE 3

Cows on A. I. V. silage trials

	BREED	MAY	JUNE	
		A. I. V. silage ration	A. I. V. silage and grass	A. I. V. silage ration ; no grass
		stability	*stability*	*stability*
Fair Maid	Brown Swiss	35¾	35½	
M86	Holstein	6		22
Lassie ...	Guernsey	26½	24½	
Quintiss	Ayrshire	31½		20

Check Cows

	BREED	WINTER HERD RATION	SUMMER RATION	WINTER HERD RATION
Lass	Ayrshire	18	17¼	
M87	Holstein	29½		15
Fawn	Guernsey	42	26	
Lotus	Jersey	36		40½

ration gave a stability value of 22 for the fat. When these test cows were turned out on grass the stability of their fat was lowered. This is in accord with what was found with the previous group tested.

No hay ration.—The Jersey cow Gem was on a ration which contained no hay during the winter. The fat had a stability of 47, later when the ration was changed to grass the stability value dropped to 38.

Wheat ration.—The Holstein cow Ida was on a ration entirely of the wheat plant. The daily ration was as follows:

Wheat (whole) ..	8.0 lb.
Wheat middlings	7.0 "
Wheat bran	5.0 "
Limestone .	0.6 "
Iodized salt	0.2 "
Wheat straw .	15.0 "

The fat had a stability value of 48.

Oat ration.—The Holstein cow M78 was on an oat ration. The daily ration was as follows.

Oats (whole)	9.0 lb.
Oat meal	9.0 "
Special steamed bone meal	0.5 "
Iodized salt ..	0.2 "
Oat straw	12.0 "

This cow developed scours during which her milk yield declined rapidly. The stability of the fat from this cow was at first 37 and later less than 16.

The data on the various cows used in these trials are given in Table 4.

TABLE 4

Cows used in fat stability tests, May and June, 1935

COW	BREED	AGE	PERIOD IN LACTATION	FLESH CONDITION	DAILY MILK YIELD	WINTER RATION	SUMMER RATION
		Years	Months				
65	Holstein	4	2	Thin	55	Herd	Herd
67	"	6	7½	"	31	"	"
68	"	2½	8	"	27	"	"
Ida	"	4½	5½	Good	16	Wheat ration	Wheat ration; no grass
M86	"	3½	7	Thin	33	A.I.V.	A.I.V.; no grass
M87	"	3½	6	Fair	32	Herd (A. I. V.-check)	No grass
M78	"	3½	3	Fair	22	Oat ration	Oat ration
404	Guernsey	7½	4	Fair	30	Herd	Herd
432	"	4	7	Fair	22	"	"
433	"	5	6	Good	24	"	"
435	"	4½	7	Fair	19	"	"
436	"	3½	3	Fair	35		
Lassie	"	4½	8	Good	15	A. I. V.	A. I. V. + grass
Fawn	"	7½	6	Medium	31	Herd (A. I. V. check)	Herd (A. I. V. check)
Gem	Jersey	3½	5	Fair	27	No hay ration	+ grass
Lotus	"	4½	6	Good	17	Herd (A. I. V. check)	No grass
Janice	Ayrshire	3	1½	Thin	42	Herd	Herd
Quintilla	"	3½	5½	Good	29	"	"
Lass	"	3½	7½	Good	21	Herd (A. I. V. check)	Herd (A. I. V. check)
Quintias	"	3½	6	Medium	18	A. I. V.	A. I. V.; no grass
Fuschia	Brown Swiss	7	5	Fair	29	Herd	Herd
Fidelity	"	4	5	Medium	30	"	"
Dora	"	3½	6½	Medium	31	"	"
Fair Maid	"	7	6	Good	30	A. I. V.	A. I. V. + grass

D. *The Relation of Various Fat Constants to Butterfat Stability*

For these trials, eight cows were selected, two from each breed—Guernsey, Jersey, Holstein and Brown Swiss. As shown in Table 5, these cows were

TABLE 5

Cows used in fat stability tests, 1936

COW	BREED	AGE	STAGE IN LACTATION PERIOD AT BEGINNING OF TEST	MAY 5, 1936 MILK YIELD
		years	*months*	*pounds*
Dora	Guernsey	$5\frac{1}{2}$	$2\frac{1}{2}$	24
Chum	Guernsey	$4\frac{1}{2}$	$2\frac{1}{2}$	24
Lotus	Jersey	$5\frac{1}{2}$	2	17
Safety Belle	Jersey	9	2	20
Fuschia	Brown Swiss	9	$1\frac{1}{2}$	27
Fidelity	Brown Swiss	$4\frac{1}{2}$	$1\frac{1}{2}$	31
Bess	Holstein	$3\frac{1}{2}$	$1\frac{1}{2}$	40
Rosette	Holstein	3	1	32

all in the early stages of their lactation period but differed in their ages. The data on the stability values and fat constants of the butterfat are given in Table 6.

Whether carotene acts as an antioxidant or prooxidant is still a debated question. The view that carotene acts as a prooxidant is taken by Olcovich and Mattill (25) and Greenbank (26), while Monagahn and Schmitt (27) found that carotene greatly inhibited the oxygen uptake of linoleic acid; but after the carotene had been oxidized it slightly accelerated the oxygen uptake of this acid. From the results reported in Table 6 it may be seen that there is no correlation between the carotene content as measured by the color of the butterfat and the stability of the fat toward oxidation.

The iodine and thiocyanogen numbers show that there is a distinct relationship between the unsaturation of the fat and its stability. In general, the greater the unsaturation the less stable is the fat. When the values for the iodine number and thiocyanogen number are plotted against stabilities as shown in Figure 2, two distinct curves result; one for the values obtained when the cows were on winter rations and one when they were receiving green grass. These results show that even though the fat was more unsaturated and less stable when the cows were receiving grass the fat was more stable for the same degree of unsaturation than when the cows were receiving winter rations. The changes brought about by grass were more pronounced in the butterfat from cows where the iodine number had been low and the stability high when on dry feed.

As shown in Figure 3, a very close relationship was found to exist between the iodine number of buttermilk and its refractive index. As the iodine number of the fat increased the refractive index increased. If refractive

TABLE 6

Relation of various fat constants to stability

COW	RATION	STABILITY VALUE	COLOR OF FAT	REFRACTIVE INDEX	IODINE NUMBER	SUN NUMBER	LINOLEIC ACID	OLEIC ACID	SAT. ACIDS
							%	%	%
February 29, 1936									
Chum	I	64	6	1.4528	26.0	24.8	1.33	26.3	68.1
Dora	I	61	6	1.4526	25.9	24.5	1.55	25.7	68.5
Fidelity	I	57½	2	1.4533	28.7	26.7	2.21	27.5	66.0
Lotus	I	57½	5	1.4530	27.2	26.7	0.56	29.2	65.9
Fuschia	I	45	3	1.4531	27.6	24.8	3.10	24.5	68.1
Bess	I	38	2	1.4533	28.1	28.4			
Safety Belle	I	32½	5	1.4536	32.2	30.2	2.21	31.4	62.1
Rosette	I	32	3	1.4543	35.5	33.1	2.66	34.2	58.8
April 7, 1936									
Lotus	II	63	5	1.4528	25.4	24.0	1.55	25.2	69.0
Dora	II	49	6	1.4526	27.1	25.4	1.88	26.4	67.4
Safety Belle	II	45	4	1.4530	28.3	27.1	1.33	28.8	65.6
Rosette	II		2	1.4542	34.6	32.2	2.65	33.2	59.9
Fidelity	II	43½	2	1.4531	27.9	26.2	1.88	27.3	66.5
Chum	II	40	6	1.4527	26.1	24.8	1.44	26.2	68.1
Fuschia	II		2	1.4529	29.0	27.6	1.55	29.2	65.0
Bess	II		2	1.4533	30.2	27.2	3.32	27.0	65.4
May 5, 1936									
Chum	III	47½	5	1.4535	29.3	26.4	3.21	26.2	66.3
Safety Belle	III	43	3	1.4532	29.2	26.3	3.21	26.1	66.4
Fuschia	IV	37	1½	1.4536	32.3	28.6	4.09	27.7	63.9
Fidelity	IV	34½	1½	1.4538	33.6	30.2	3.75	29.8	62.2
Lotus	III	33½	6	1.4534	30.2	27.1	3.42	26.8	65.5
Bess	IV	28	1	1.4543	36.3	32.6	4.09	32.2	59.4
Rosette	IV	24½	1½	1.4553	42.3	38.0	4.76	37.6	53.3
Dora	III		6	1.4532	31.6	27.8	4.20	26.7	64.8

TABLE 6—(Continued)

COW	RATION	STABILITY VALUE	COLOR OF FAT	REFRACTIVE INDEX	IODINE NUMBER	SCN NUMBER	LINOLEIC ACID	OLEIC ACID	SAT. ACIDS
				May 19, 1936					
Lotus	V	38	7	1.4545	35.5	32.0	3.87	31.7	60.1
Dora	V	37	8	1.4543	35.5	32.4	3.43	32.6	59.7
Safety Belle	V	33½	7	1.4546	38.0	34.7	3.65	35.0	57.1
Chum	V	32½	10	1.4547	37.4	34.8	2.88	35.9	56.9
Fuschia	V	28½	2½	1.4552	42.4	38.2	4.65	37.9	53.2
Fidelity	V	27½	2½	1.4553	41.9	38.3	3.98	38.6	53.1
Bess	V	26½	2	1.4551	39.8	35.4	4.87	34.5	56.3
Rosette	V	25½	2½	1.4561	44.1	41.0	3.43	42.2	50.1

Rations—Mixed hay throughout

I
Corn Silage
5—corn
2—oats
2—bran
1—oil meal

II
Corn Silage
Corn-alfalfa silage
5—corn
3—oats
2—bran

III
Corn-alfalfa A. I. V. Silage
One Feed
5—corn
3—oats
2—bran

A. I. V. alfalfa silage
One Feed
5—corn
5—oats

IV
Same as III except molasses silage instead of A. I. V.

V
Cows on grass May 11
Alfalfa mixed hay
Small amount of A. I. V. alfalfa silage
5—corn
5—oats
5—bran
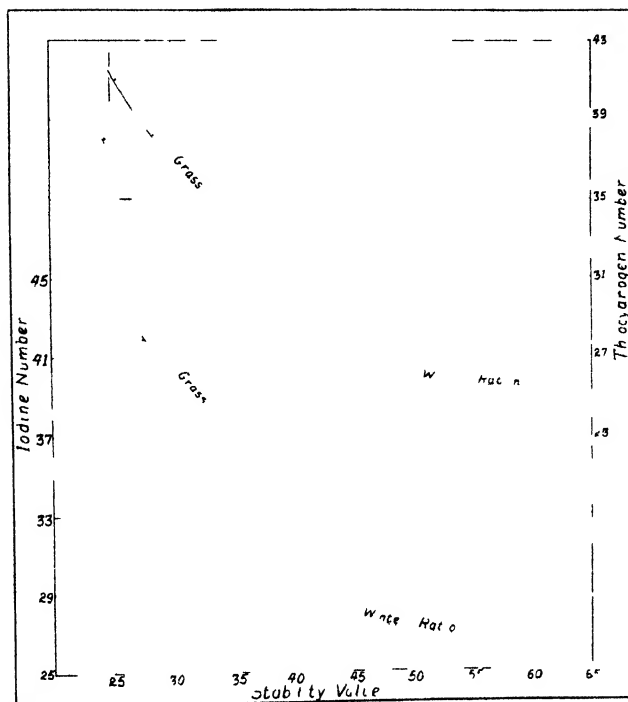
FIG 2 RELATIONSHIP BETWEEN THE UNSATURATION OF BUTTERFAT AND ITS STABILITY TOWARD OXIDATION
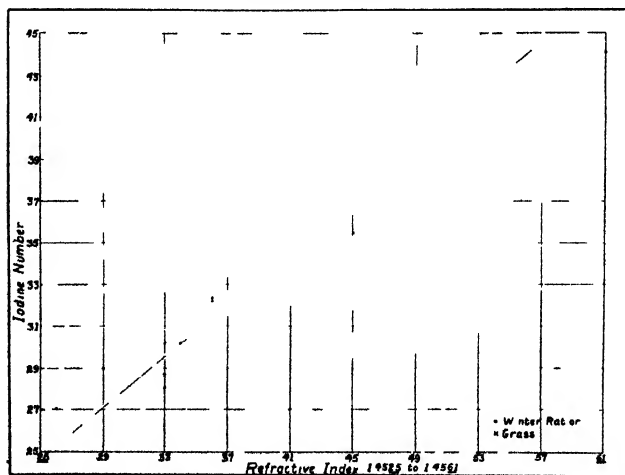
FIG 3 RELATIONSHIP BETWEEN THE IODINE NUMBER AND REFRACTIVE INDEX OF BUTTERFAT.

indices are plotted against stability values, curves are obtained which are similar to those in Figure 2.

Figure 4 shows the curves obtained by plotting the percentages of oleic and linoleic acids against stability of the various samples of butterfat.   In
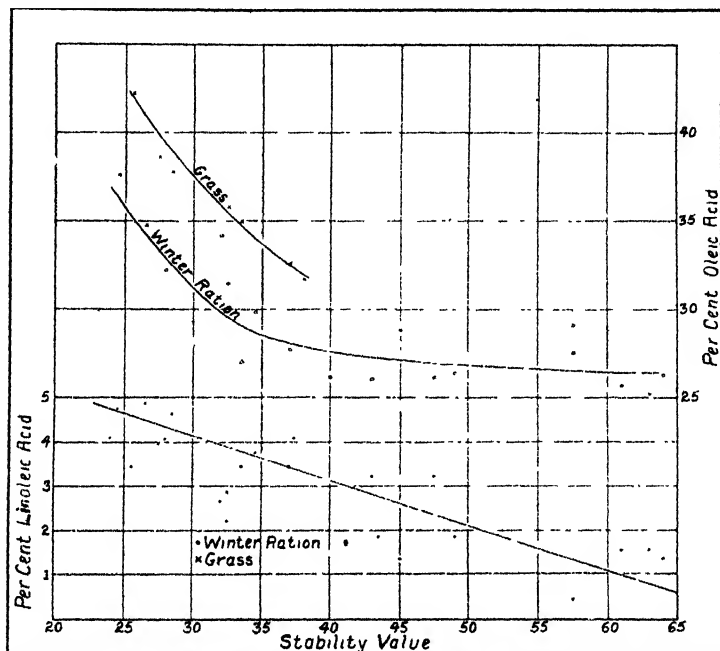
FIG. 4.   RELATIONSHIP BETWEEN THE AMOUNTS OF OLEIC AND LINOLEIC ACIDS AND THE STABILITY OF THE BUTTERFAT TOWARD OXIDATION.

the case of oleic acid, two distinct curves are produced similar to those in Figure 2, one for the fat when the cows were on dry feed and the other when the cows received grass.   The percentage of linoleic acid appears to be a straight line function of the stability of the fat; decreasing as the stability of the fat increases.   The fact that the linoleic acid values for the butterfat from the cows on grass fall on the same curve as the values for the butterfat from the cows on winter rations leads to the conclusion that the percentage of linoleic acid determines the stability.

<center>DISCUSSION</center>

The findings in these trials that the stability of the fat was influenced by its unsaturation is in accord with those of Henderson and Roadhouse (12) who found that the fat from cows on sub-maintenance rations was more unsaturated and more susceptible to oxidation.

In trials covering the spring periods of 1935 and 1936, the authors have shown that when the cows were turned out on grass the fat became more sus-

ceptible to oxidation. These results seem to be contrary to practical experience and scientific observations (1, 9) that the milk from cows on grass is less apt to develop oxidized flavors than when on dry feed. These findings lead the authors to believe that there are protective substances in milk which become more plentiful when the cows are on grass and which prevent the oxidation of the fat even though the separated butteroil is more susceptible to oxidation. The presence of protective substances might explain why Frazier (15) was unable to determine any difference in the development of a tallowy flavor in the milk of cows fed a ration which should have caused the fat to be less saturated and more subject to oxidation.

Although the rations of the cows are included in the data of this paper, no attempt was made in these trials to influence the stability of the fat by changing the ration of the cow.

From the data obtained in these trials it is impossible to attribute the variations in the stability of the milk fat of the various cows or of the same cow at different periods to the age of the cow or the stage in her lactation period.

SUMMARY

There is considerable variation in the stability of the butterfat toward oxidation from different cows and from an individual cow at different times.

The stability of butterfat toward oxidation bears an inverse relation to the unsaturation of the fat.

The fat from cows receiving grass as part of their ration is less saturated and more susceptible to oxidation.

It appears that the amount of linoleic acid rather than the oleic acid governs the stability of butterfat.

The results point to the presence of protecting substances in milk in increased amounts when cows are on grass which prevents the development of oxidized flavors in milk. .

There is no relation between the carotene content, as evidenced by the color of the fat, and the stability of the fat toward oxidation.

The refractive index of butterfat varies in direct proportion [....] e iodine number of the fat.

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THE EFFECT OF HOMOGENIZATION AT DIFFERENT TEMPERATURES ON SOME OF THE PHYSICAL PROPERTIES OF MILK AND CREAM

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The behavior of dairy products homogenized or viscolized at or near the pasteurization temperature has been the subject of many papers and the effects of this process on hot milk and cream and other dairy products are well known. Considerably less attention has been given to the homogenization of milk and cream at temperatures below the melting point of butterfat.

Doan (1, 2, 3) has reported many changes which occur when homogenization is conducted at 100° F. He has shown (4) that the clumping of the fat globules and feathering in coffee is more pronounced when cream is processed at 80° F. than at 180° F. Trout, Halloran and Gould (5) have listed the properties of milk homogenized at 90° F. Rahn (6) studied the distribution and size of fat globules in milk homogenized at 68° F. Dorner and Widmer (7) found that raw milk held 24 hours and homogenized at 41° F. failed to develop a rancid flavor. "Milk drawn only some hours before homogenization became rancid rapidly even if it was cooled to 5° C. (41° F.) and homogenized at this temperature." They concluded that milk processed at this temperature could not be rightfully called homogenized milk, judging from the microscopic appearance.

It is the purpose of this paper to record the observations made on certain properties of milk and cream which were homogenized at various temperatures from 50° to 175° F. and to show the influence of the temperature history of the product prior to its processing.

EXPERIMENTAL

Raw whole milk containing 4.0 per cent fat was thoroughly mixed and divided into 19 portions. These portions were treated in various ways as indicated in Table 1. Two methods of adjusting the milk to the indicated temperature were employed. The first consisted of raising the temperature of the milk, previously held for 18 hours at 40° F. to thoroughly harden the fat, to the homogenization temperature. The heating was done in a careful manner, using a heating medium not over 10° above that of the product. The second consisted of preheating the milk to 145° F. in order to melt the fat and cooling rapidly over a surface cooler to the homogenization temperature. One sample was also processed at 175° F. The samples were pasteurized for 30 minutes at 145° F. immediately after homogenization. Three unhomogenized controls were also included in the series, one being the aged

raw milk, one being milk pasteurized at 145° F. for 30 minutes and the third flash pasteurized at 175° F. All homogenization was conducted at a pressure of 3000 lbs. per sq. in. using a single stage valve.

Raw 20 per cent cream was treated in the same manner as milk.

After completion of the work described above, the samples were aged over night at 40° F. and then examined as follows:

Milk

Microscopic examination. This included recording the average size of the fat globules and the extent of the fat globule clumping. The milk was diluted with 40 parts of distilled water and a hanging-drop slide prepared. About 10 fields were examined.

Cream volume. The milk was allowed to cream at 40° F. in pint milk bottles and the volume of cream determined in percentage after 24 hours.

Curd tension. Curd tension was determined in duplicate according to the method of Hill (8).

Flavor. The flavor was judged by two experienced judges.

Cream

Microscopic examination. This was the same as for milk except a dilution of 1 part of cream to 200 parts of water was made.

Body. The body or viscosity was measured with a Saybolt Viscosimeter having a tip orifice diameter of 0.082 inches. The number of seconds required to fill a 60 cc. flask at 50° F. was recorded.

Feathering in coffee. Coffee was prepared by mixing 40 grams of freshly ground coffee and 500 cc. distilled water, bringing the mixture to the boiling point. After filtering, the coffee was held in test tubes in a boiling-water bath until ready for use. One cc. of cream was added to 20 cc. of hot coffee and observed for feathering.

Skim layer. The depth of skimmilk layer which formed on the bottom of a pint bottle of cream, after standing over night at 40° F. expressed in inches was termed the skim layer.

Flavor and color. These were judged by two experienced judges.

RESULTS

The observations made on a typical sample of milk, treated as described above, are recorded in Table 1. Table 2 contains the data collected on a typical sample of 20 per cent cream. It will be seen that the temperature of processing had an influence on all of the factors studied. It will also be seen that the effects noted depended in some cases on whether the milk was adjusted to the processing temperature by raising the temperature from 40° F. or by lowering it from 145° F.

Milk (Table 1)

Size of fat globules. Using milk which has been held over night to harden the fat, homogenization at 50, 60 and 70° F. failed to alter the size of the

TABLE 1

The influence of the temperature of homogenization on some of the physical properties of whole (4%) milk. Homogenization was at a pressure of 3000 lbs. per sq. in. using a single stage valve. After homogenizing the milks were pasteurized for 30 minutes at 145° F. and aged 18 hours at 40° F.

HOMOGE-NIZING TEMPERA-TURE	TEMPERATURE HISTORY OF MILK	AVERAGE SIZE FAT GLO-BULES	FAT GLOBULE CLUMPING	CREAM VOLUME	CURD TENSION	FLAVOR
° F		microns		%	gms.	
50	Held over night at 40°	3–9	–	11	45	Good
	Heated at 145° & cooled	3–9	–	6	45	Good
60	Held over night at 40°	3–9	–	3	40	Good
	Heated to 145° & cooled	3–8	–	3	40	Good
70	Held over night at 40°	3–9		3	45	Good
	Heated at 145° & cooled	3–6	–	0	35	Good
80	Held over night at 40°	3–6	–	3	38	Slightly off
	Heated to 145° & cooled	2–5	–	0	30	Good
90	Held over night at 40°	3–6	–	0	30	Rancid
	Heated to 145° & cooled	2–5		0	30	Good
100	Held over night at 40°	2–5	·	0	28	Rancid
	Heated to 145° & cooled	1–3	·	0	30	Good
120	Held over night at 40°	1–3	+	0	25	Good
	Heated to 145° & cooled	1–3	+	0	25	Good
145	Heated from 40°	1–3	+	0	25	Good
175	Heated from 40°	1–3		0	28	Cooked
Unhomogenized raw milk control		3–9	+++	22	50	Good
Unhomogenized pasteurized (145° F.) control		3–9	+	22	45	Good
Unhomogenized pasteurized (175° F.) control		3–9	–	3	20	Cooked

Key: – = none
+ = slight
++ = definite
+++ = pronounced
++++ = extreme

globules. At 80° there was a slight subdivision and at 100° F. more noticeable subdivision was noted. At 120° and 145° F. the globules were very small. When the milk had been heated to 145° F. to melt the fat very small

globules were obtained when homogenizing temperatures of 145°, 120° and 100° F. were employed. At 90° F. and 80° F. noticeable subdivision was observed, while below these temperatures there was relatively little change in size of the globules.

Fat globule clumping. No clumping of the fat globules was noted under the microscope in any of the homogenized milk samples processed at 90° F. or less. Very slight clumping was noted above 100° F.

Cream volume. Homogenization at temperatures of 90° F. and above eliminated the cream line. It was destroyed at a lower temperature (70° F.) when the milk had been first warmed to 145° F. to melt the fat and then cooled to the homogenizing temperature. Marked reduction in cream volume was noted on all of the homogenized samples and in the unhomogenized control heated to 175° F.

Curd tension. A reduction in curd tension was observed whenever the homogenizing temperature was 90° F. and above. More effective reduction in curd tension was obtained by cooling down to the homogenizing temperature than by warming up. Merely heating to 175° F. also reduced the curd tension.

Flavor. The only off flavor, other than cooked taste caused by high temperature, was the rancid flavor which is generally assumed to be the result of hydrolysis of the fat by the enzyme lipase. Rancidity develops to a much greater extent in raw homogenized milk than in unhomogenized milk because of the greater fat surface exposed to lipolytic action (7). In this experiment the surface of fat exposed was sufficiently increased in the samples homogenized at 80°, 90° and 100° F. to bring about this flavor defect. Apparently heating to 120° F. or higher rendered the enzyme inactive. Temperatures below 80° F. did not provide sufficient surface to bring out the flavor.

Cream (Table 2)

Size of fat globules. In the samples homogenized at the lower temperatures great irregularity in fat globule size was noted. Because of the frequency of globules having a diameter of approximately 15 microns, it seems probable that there was some coalescence of the fat globules. As the temperature of homogenization was raised the tendency to produce small fat globules was increased, depending on the previous temperature history of the sample. A minimum temperature of 90° F. was required to produce noticeable subdivision of the fat globules, when the chilled cream had been warmed from 40° F.; whereas a minimum of 80° F. was sufficient to produce equivalent results when the cream had been preheated to 145° F. Very little clumping was noted in the unhomogenized samples.

Fat globule clumping. Again the previous temperature history of the sample influenced the minimum temperature at which homogenization produced fat globule clumping. Some clumping was observed at 80° F. when

TABLE 2

The influence of the temperature of homogenization on some of the physical properties of 20 per cent cream. Homogenization was at a pressure 3000 lbs. per sq. in. using a single-stage value. After homogenizing the creams were pasteurized for 30 minutes at 145° F. and then aged 18 hours at 40° F.

HOMOGENIZING TEMPERATURE °F	TEMPERATURE HISTORY OF MILK	AVERAGE SIZE FAT GLOBULES microns	FAT GLOBULE CLUMPING,	BODY AT 50° F. Saybolt Secs.	FEATHERING IN HOT COFFEE	SKIM LAYER IN PT. BOTTLE inches	FLAVOR	COLOR
50	Held over night at 40°	1-15	-	28	-	slight	Good	Light cream
	Heated to 145° & cooled	1-15	-	41	+	slight	Good	Very light cream
60	Held over night at 40°	1-15	-	28	-	slight	Good	Light cream
	Heated to 145° & cooled	1-10	-+	767	+++	1/8	Good	Very light cream
70	Held over night at 40°	1-15	-	31	-	slight	Good	Light cream
	Heated to 145° & cooled	1-8	+++	TT	-++	1/8	Good	Very light cream
80	Held over night at 40°	1-10	-	44	++	slight	Good	Light cream
	Heated to 145° & cooled	2-3	+++	TT	+++	1/8	Good	Very light cream
90	Held over night at 40°	2	+++	TT	+++	1/8	Slightly off	Very light cream
	Heated to 145° & cooled	2-3	+++	TT	+++	1/8	Good	Very light cream
100	Held over night at 40°	2	+++	TT	+++	1/8	Slightly off	Very light cream
	Heated to 145° & cooled	2	+++	TT	+++	1/8	Good	Very light cream
120	Held over night at 40°	2	+++	TT	+++	1/8	Good	Very light cream
	Heated to 145° & cooled	1-2	+++	TT	+++	1/8	Good	Very light cream
145	Heated from 40°	3	+++	350	+++	slight	Good	Very light cream
175	Heated from 40°	2-3	+-+	TT	+++	0	Slightly cooked	Very light cream
Unhomogenized raw cream control		3-8	+	59	-	1/8	Good	Cream
Unhomogenized pasteurized (145°) control		3-10	+	31	-	slight	Good	Cream
Unhomogenized pasteurized (175°) control		3-8	-	34	-	slight	Cooked	Cream

Key: - = none + = slight ++ = definite +++ = pronounced ++++ = extreme TT = too thick to measure

the cream had been previously chilled, while cream cooled to 50° F. from 145° F. exhibited some clumping upon homogenization. Above these minimum temperatures homogenization caused extreme clumping.

Body. The temperature of homogenization very markedly influenced the body. This more or less paralleled the fat globule clumping. A slight decrease in viscosity as compared to the unhomogenized control was observed in those samples which had been prepared from chilled cream and homogenized at low temperatures.

Feathering in hot coffee. The temperature of homogenization had a very pronounced effect upon the feathering of the cream in coffee. Feathering was noted in all the homogenized samples except at 50°, 60° and 70° F. when the cream had first been held over night at 40° F. No feathering was noted in any of the controls.

Skim layer. The temperature of homogenization had little effect on the skim layer.

Flavor. Aside from a slight cooked or heated cream flavor in the samples heated to 175° F., there was no pronounced difference in flavor among the samples. A slight off flavor was noted in the samples homogenized raw at 90° and 100° F.; however, unlike the homogenized milk, this flavor was not definitely identified as rancid.

Color. Homogenization at all temperatures had an effect upon the color of the cream as compared to the controls. A decrease in color paralleled the effectiveness of homogenization.

<div align="center">DISCUSSION</div>

Data have been presented to show that homogenization at temperatures ranging from 50° to 175° F. has a marked influence on various properties of milk and cream. For good homogenization, as evidenced by extensive subdivision of the fat globules, it is apparently necessary to have the fat in a more or less liquid state. This condition always exists when the processing temperature is 100° F. or higher. When temperatures below those usually employed were used the method of adjusting the temperature was found to affect the results. From the data presented in this paper it is possible to speculate as to the condition of the butterfat at the various temperatures used. Table 3 summarizes the conclusions drawn in this regard.

An interesting observation made in connection with this research was in the homogenization of cream at 70° F. Two lots of 20 per cent cream at 70° F. were prepared, one lot having been adjusted to this temperature after aging at 40° F., and the other heated to 145° F. and then cooled to 70° F. Various proportions of these two lots of cream were immediately mixed and homogenized at a pressure of 3000 lbs. per square inch. Microscopic examination of these homogenized creams showed both homogenized and unhomogenized fat globules, the amounts of each roughly paralleling the proportion of liquid to solid fat as determined by the source of cream. The extent

TABLE 3

The condition of butterfat in milk and cream at various temperatures ranging from 50° to 175° F. as influenced by the temperature history. The condition of the fat was indicated by the properties of the homogenized product

HOMOGENIZING TEMPERATURE	TEMPERATURE HISTORY OF PRODUCT	
	Aged at 40° F before homogenization	Heated to 145° F. before homogenization
° F.		
50	solid	solid
60	solid	soft
70	solid	soft
80	soft	liquid
90	soft	liquid
100	liquid	liquid
120	liquid	liquid
145	liquid	liquid
175	liquid	liquid

of fat globule clumping, feathering, and the viscosity were governed by the proportion of liquid fat in the homogenized mixture.

SUMMARY

1. Data are presented on several properties of milk and cream as influenced by single-stage homogenization at a pressure of 3000 lbs. per square inch at various temperatures ranging from 50° to 175° F.

2. The butterfat in milk and cream must be liquid or in a relatively soft condition in order to obtain, upon homogenization, changes in the recorded properties.

3. The condition of the butterfat existing in milk and cream immediately after adjustment to temperatures between 60° and 90° F. depends upon the temperature treatment of the product prior to its adjustment to these temperatures.

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American Dairy Science Association Announcements

THIRTY–SECOND ANNUAL MEETING, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA AGRICULTURAL COLLEGE CAMPUS, JUNE 22–25, 1937

GENERAL INFORMATION

Lincoln is a city of 80,000 people, the capital of the State of Nebraska. Within the city or in its environs, are located the University of Nebraska, Nebraska Wesleyan University, and Union College. Morrill Hall, the museum of the University of Nebraska, has the finest collection of fossil elephants in the world and is one of the good museums of natural history in the United States. The Nebraska State Capital is considered by architects one of the most outstanding buildings in America. Lincoln is located on the main line of the Burlington Railway between Chicago and Denver, and on the main line of the Rock Island between Chicago and Kansas points. It is also served by the Union Pacific, Northwestern, and Missouri Pacific. Highway U. S. 6, the cross continental highway, runs through Lincoln and U. S. 77 carries traffic north and south. Main highways from Lincoln lead to the Yellowstone and Rocky Mountain National Parks and to the Black Hills. The lake region of Minnesota can be reached easily by good highways.

HOUSING

Those attending the meetings can obtain accommodations at the hotels of Lincoln. Each member of record last fall will be sent a list of hotels showing the kind of accommodations that can be obtained, for one or for a party. In addition to the hotels, accommodations may be obtained for the men at the Y. M. C. A. and at the Alpha Gamma Rho house. To facilitate the housing, it is requested that reservations be made through Prof. H. P. Davis, Dairy Husbandry Department, University of Nebraska, Lincoln, Nebraska. As soon as the hotel has confirmed the reservation notification will be sent out. The cost of rooms will vary from .75c to $2.50 per day depending upon the accommodations.

JOURNAL OF DAIRY SCIENCE

THE LACTOGENIC PREPARATIONS FROM THE ANTERIOR PITUITARY AND THE INCREASE OF MILK YIELD IN COWS

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INTRODUCTION

After the well-known papers of Grüter and Stricker (11, 20), showing the possibility of influencing the lactation of farm animals by extracts from the anterior pituitary, few papers have subsequently appeared confirming these preliminary observations (8, 15, 16, 19) on the rôle of the anterior pituitary in the lactation phenomena. In 1932, Riddle, Bathes and Dykshorn (17) discovered the hormone of lactation, "prolactin." This discovery has stimulated still more the study of physiology of the hypophysis and of its rôle in the lactation of Mammalia.

Since January, 1932, my collaborators and I have carried out a series of experiments on laboratory animals (rabbits, guinea-pigs, dogs, rats) and on cows, investigating the mechanism of lactation generally and of the increase of milk yield in cows. In a series of tests we are able to prove, first of all, that the so-called prolan (from the urine of pregnant women) is not capable of inducing lactation (in dogs, rabbits) or of stimulating milk yield in cows (1, 2). In this respect our results disagree with the findings of Hupka and Majert (12), according to whom prolan seems to influence the increase of milk yield in cows.

We also did considerable work in the production and study of different lactogenic preparations from the anterior pituitary. Some of these preparations produced in the form of powder are similar in their action to liquid lactogenic preparations from the anterior pituitary (3). The purpose of this work was to secure the production of a lactogenic preparation free from other hormones of the anterior pituitary (gonadotropic and thyreotropic hormones, growth hormone, etc.). Besides, we have naturally tested the lactogenic preparations produced by the method of Riddle, Bathes and

Dykshorn (17), as well as by the method of Lyons and Catchpole (14) and of Turner and Gardner (10).

Laboratory animals (rabbits, etc.) were used as controls and also cows and pigs on which were tried absolutely all variations of the preparations. It has to be noted that from the very beginning a sharp difference became apparent between the action of two groups of preparations upon the course of lactation in the cow: preparations of the type of prolactin of Riddle, Bathes and Dykshorn and lactogenic preparations produced mainly by the method of Evans (9), *i.e*, preparations containing besides prolactin several other hormones of the hypophysis. Preparations of the prolactin type, while giving invariably a positive reaction on pigeons and rabbits, did not induce in our experience an increase of the milk yield in lactating cows, both normal and castrated. In the cows a positive effect could always be produced by the so-called *total* preparation from the anterior pituitary, i e, by the lactogenic preparation from the anterior pituitary containing a whole number of the hypophysis hormones. This statement holds good even when the doses of "pure" prolactin were increased two, three and more times compared with the "total" preparations. Even if the "pure" prolactin sometimes gave a positive result (increased milk yield) it was very unsteady and that only after doses ten times and higher than those of the "total" preparation.

We have already mentioned that by the name of "total" preparation we have in our experiments conditionally called the extract from the anterior pituitary produced by us, with some slight modifications, by the method used by Evans to produce the growth hormone (9, 3). This preparation was later improved by us, produced in a dry state, freed considerably by repeated freezing from superfluous proteins, etc. We usually used freshly prepared lactogenic preparations, although we also secured positive results from preparations (dry) stored for six and more months.[1] .

During the described period (since 1932) we have carried out numerous tests on a large number of cows (in all considerably over 2000 head of different breeds, age, number of lactations, month of lactation, under different conditions of feeding, at different seasons, barren and pregnant, normal and

[1] *Method of preparation.* The anterior pituitary of cattle is thoroughly ground and diluted with six times its volume of distilled water, temperature $+1°$ C., stirred for 30 minutes and then added 1.5 volumes of 0.2 N $Ba(OH)_2$, also previously cooled. Mixing continued for one hour and then placed overnight on ice, temperature $0°$ to $+4°$ C. The extract is separated from the remains of tissue by filtration through gauze. To the extract is added 0.2 N H_2SO_4 till obtaining about pH 8.0. Ten minutes later a few crystals of Na_2SO_4 are added. The extract is placed on ice over night, then centrifuged and the liquid conserved with a few drops of tricresol. Keep on ice. In order to obtain a frozen preparation the centrifuged extract is frozen at $-10°$ C. After thawing an almost limpid liquid is poured off, which is used for injecting the cows. The "dry" preparation was obtained by precipitating the alkaline extract at the isoelectric point by adding 1% solution of acetic acid. The precipitate is dried with non-aqueous acetone. Before use this powder is diluted in 1% solution of Na_2HPO_4. The insoluble residue is thrown out.

castrated.   It is obvious that we have gathered much very valuable experimental material, part of which was printed by us in Soviet publications (1, 2, 3, 4, 5, 6, 18).   The sum total of our tests rendered it possible to arrive at present at a definite conclusion, that namely, *the lactogenic preparations from the anterior pituitary made in our laboratory induce an increase of the milk yield in lactating cows.   In certain series of tests this increase of the milk yield has reached seven and more liters of milk per day (three milkings).*

This increase of the milk yield takes place not only upon *a single* injection of the preparation, but also when it is used repeatedly in a prolonged experiment (18) in which the total preparation had been injected every ten days to a group of cows during 3½ months, *i.e.*, each cow received 10 injections.   A fresh extract from the anterior pituitary was prepared each time. All cows, with few exceptions, have reacted by an increase of the milk yield after each injection of the preparation.   Thus by this test (and by other tests), it was shown that it is possible to repeat the injection of the lactogenic substances from the hypophysis not only once but several times and to get in each case an increase of the milk yield.

As we have gradually gathered considerable practical material of several series of tests in each of which however participated only a relatively small group of animals it became logically necessary: (a) to arrange a simultaneous experiment on a large herd of cattle at one State Farm; (b) to check finally the possibility of *practical* application of the lactogenic preparations of the hypophysis.

This was accomplished in November, 1935, to January, 1936, at one of the large State Farms in the vicinity of Moscow.

SELECTION OF ANIMALS

Originally it was intended to carry out the test at one cowbarn only (the 4th) on 170 head of cattle, but, as the injection of the preparation to 138 cows at cowbarn No. 4 gave during 12 days more than 1900 liters of milk above the usual production, we decided at the request of the management of the State Farm to include three more cow barns (2nd, 3rd and 5th).

Thus in the experiment were included milk cows at four cowbarns of the State Farm with the exception of: (a) champion cows, (b) dry cows, (c) cows within 20 days after calving and (d) obviously sick cows.   In all, injections were given to 510 cows.   A control group of 90 cows was selected as well (Table 1).

TABLE 1
Distribution of cows in the cowbarns

GROUP/COWBARNS	NO. 4	NO. 2	NO. 3	NO. 5	TOTAL
Experimental	138	115	154	103	510
Control	28	18	22	22	90
Total	166	133	176	125	600

Breed. The bulk of experimental animals consisted of non-pedigree cows, 220 head (36.6 per cent of the total number—600 cows), and Yaroslav, 186 head (31 per cent), followed by Kholmogor, 65 head (10.8 per cent), Simmental, 67 head (11.2 per cent). The rest was made up by a small number of such breeds as Swiss (4.2 per cent), Red Gorbatov, Red German, Tagil, etc. (Table 2).

TABLE 2
Breed of test animals

GROUP	NON-PEDIGREE	YAROSLAV	KHOLMOGOR	SIMMENTAL	SWISS	RED GORBATOV	RED GERMAN	TAGIL	BROWN LATVIAN	DANISH	YUTLAND	TOTAL
Experimental	182	164	53	56	21	17	2	6	3	5	1	510
Control	38	22	12	11	4	1	–	–	1	1	1	90
Total	220	186	65	67	25	18	2	6	4	6	1	600

Age. Table 3 shows that the bulk of experimental animals—421 cows (71.2 per cent)—consisted of cows born between 1924 and 1928, *i.e.* cows with 7–10 calvings.

TABLE 3
Age of test animals

| GROUP | YEAR OF BIRTH | | | | | | | | | | | | | | TOTAL |
	1920 and earlier	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	
Experimental	10	9	35	48	97	76	95	62	30	13	10	6	17	2	510
Control		1	7	13	16	17	16	4	7	1	3		4	1	90
Total	10	10	42	61	113	93	111	66	37	14	13	6	21	3	600

Milk yield. The milk yield of cows in about 50 per cent of cases amounted to 6 to 12 l. Table 4 gives an idea of the average daily milk yield during the preliminary period.

TABLE 4
Distribution of cows according to milk yield (preliminary period)

| NUMBER | MILK YIELD IN LITERS (FROM—TO) | | | | | | | | |
	1–3	4–6	7–9	10–12	13–15	16–18	19–21	22–24	25–27
No. 4		9.3	19.6	30.4	19.6	12.1	3.5	..	..
No. 2	3.5	9.5	27.8	22.6	19.1	12.1	3.5	1.8	...
No. 3	1.3	16.9	24.0	24.4	18.1	9.0	2.5	1.3	2.5
No. 5	.	7.7	23.0	30.0	12.5	17.3	9.6	...	..

Note.—The figures represent the percentage of cows yielding a given amount of milk.

TABLE 5

Distribution of cows according to live weight

GROUPS	LIVE WEIGHT OF TEST AND CONTROL ANIMALS (KG)														WEIGHT UNKNOWN	TOTAL
	300–325	326–350	351–375	376–400	401–425	426–450	451–475	476–500	501–525	526–550	551–575	576–600	601–625	620–650		
Experimental	1	5	12	39	58	95	66	88	61	42	11	5	7	4	16	510
Control			3	5	6	17	10	17	9	14	3	4		1	1	90
Grand total	1	5	15	44	64	112	76	105	70	56	14	9	7	5	17	600

TABLE 6

State of pregnancy

COWBARN NO.	GROUPS	BARREN				PREGNANT				GRAND TOTAL
		Recently calved	From 4 to 11 months	Over 11 months	Total	1 to 4 months	5 to 7 months	Total	Month unknown	
4	Experimental	28	48	8	84	27	25	52	2	138
	Control	5	6	6	17	5	6	11		28
	Total	33	54	14	101	32	31	63	2	166
2	Experimental	24	31		55	28	30	58	2	115
	Control	4	4	1	9	3	5	8	1	18
	Total	28	35	1	64	31	35	66	3	133
3	Experimental	28	43	7	84	38	30	68	2	154
	Control	7	7	2	16		6	6		22
	Total	35	50	9	100	38	36	74	2	176
5	Experimental	9	20	1	30	47	25	72	1	103
	Control	2	3	1	6	9	7	16		22
	Total	11	23	2	36	56	32	88	1	125
Altogether in the test	Experimental	89	148	16	253	140	110	250	7	510
	Control	18	20	10	48	17	24	41	1	90
	Total	107	168	26	301	157	134	291	8	600

TABLE 7

Distribution of the animals according to the month of lactation

COW-BARN	GROUPS	\<-- MONTH OF LACTATION --> 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	UN-KNOWN	TOTAL
4	Experimental	9	14	10	7	12	21	21	12	8	6	3	6	1	2			1	1		1		3	138
	Control	2	4	1	1	3	3	3	3	2	3		1		1				1					28
	Total	11	18	11	8	15	24	24	15	10	9	3	7	1	3			1	2		1		3	166
2	Experimental		13	12	8	12	7	12	15	14	7	6	2	2		1					3		1	115
	Control		1	4		1	1	2	2	2	1	2			2									18
	Total		14	16	8	13	8	14	17	16	8	8	2	2	2	1					3		1	133
3	Experimental		12	18	11	10	13	16	16	13	6	11	2	5	5	3			2	1	1	1	8	154
	Control		3	4	1	1	3	2	2	1	2	1		1	1									22
	Total		15	22	12	11	16	18	18	14	8	12	2	6	6	3			2	1	1	1	8	176
5	Experimental		6	8	9	5	15	22	12	8	6	6	1	1			1		2				1	103
	Control		2	1	2	2	2	3	2	3		1	1						1		1		1	22
	Total		8	9	11	7	17	25	14	11	6	7	2	1			1		3		1		2	125
Altogether in the test:	Experimental	9	45	48	35	39	56	71	55	43	25	26	11	9	7	4	1	1	5	1	5	1	13	510
	Control	2	10	10	4	7	9	10	9	8	6	4	2	1	4				2		1	0	1	90
	Grand total	11	55	58	39	46	65	81	64	51	31	30	13	10	11	4	1	1	7	1	6	1	14	600

Live weight. The bulk of the animals was composed of cows weighing from 425 to 500 kg. (Table 5). Taking into account the breed it can be stated that the cows were in good or above the average state of fleshiness. Varied rations rich in protein contributed to it.

Pregnancy. All the experimental animals can be divided into 4 groups: (a) barren after recent delivery (1–3 months after calving), (b) barren (during 4–11 months), (c) barren (over 11 months), and (d) pregnant cows. As can be seen from Table 6 in our experiment were included 301 barren cows (50.1 per cent of the total).

Lactation month. Table 7 shows that in 85 per cent of cases the animals had a normal course of lactation (from 1 to 10 months).

Control group. In the control group were gathered animals (Tables 2–7) approaching in all indices as near as possible the cows, which received injections of the preparation from the anterior pituitary.

FEEDING AND KEEPING

The cows were fed at cowbarns individually twice a day and milked 3 times a day. Cows at cowbarn No. 4 were receiving the following ration: steppe hay composed of different herbs (7–8 kg.), dried sugar-beet press (1–4 kg.) and a mixture of concentrates, comprising 40 per cent of sunflower oil cake, 30 per cent of group oats and 30 per cent of wheat bran (1.5–10 kg.). One kg. of this mixture equals 0.99 feed unit and contains 153 grams of protein. With each meal the cows also received mineral food made up of common salt and ground chalk.

The ration of the other cowbarns included: meadow hay of medium quality, sugar beet press, mixture of concentrates consisting of 40 per cent of sunflower oil cake, 30 per cent of barley, as well as mineral food. In addition at cowbarns No. 2 and 5 sunflower silage was given to the amount of 50 per cent of the total quantity of succulent feeds.

The cows received as much water as they wanted from the automatic waterers.

After injection of the anterior pituitary preparation the milk yield increased in the great majority of cows. At that period the cows received additional concentrates, usually following the increase in the milk yield.

However at different cowbarns different variations of additional feed were tried. The following method was adopted at cowbarn No. 4. From the beginning of the preliminary period (11/28/1935) up to the end of the test all experimental animals (reserved for injection as well as control ones) were placed on surplus ration, receiving a surplus of concentrates calculated on the basis of additional two liters of milk above the actual average daily milk yield. Beginning with the second day of the increase in the milk yield (under the influence of the preparation) all cows received additional concentrates calculated on the basis of actual increase in the milk

yield the day before. In proportion to the gradual drop in the milk yield following the ceasing of the action of the lactogenic preparation the additional feed was also reduced.

At the other three cowbarns we used a different system of additional feeding. Remaining before injection on the usual farm ration, experimental as well as control animals began to receive during the period of the action of the preparation, starting with the second day of the increase in the milk yield, additional concentrates. This additional feed, which corresponded to the maximum increase of the milk yield, lasted until the end of the experiment, when in spite of the continued additional feeding, the milk yield started to fall following the cessation of the action of the preparation until it had reached the former pre-injection level. However in many cows the increase in the milk yield lasted throughout the experimental period. The control group of cows also received supplementary concentrates calculated on the basis of minimum two additional liters of milk per day per cow. As will be seen later it nevertheless had little effect on the increase of milk yield on the control group.

INJECTIONS OF THE PREPARATION AND REGISTRATION OF THE MILK YIELD

In the present experiment we used the total preparation from the anterior pituitary of cattle. Injections were given as usual, subcutaneously, in the region of the neck, each injection consisting of 50 cc. of freshly made up preparation, which corresponds approximately to about six grams of the hypophysis. There was not a single case of painful affection following the injection of the preparation.

At the fourth cowbarn the measuring of the milk yield was done by weighing on special weighing machines and the amount of milk was then expressed in liters. At the other cowbarns the measuring was done by a milk-meter.

RESULTS OF THE EXPERIMENT

As usual in our experiments, the increase of the milk yield in cows receiving injections started in about 24 hours and lasted several days. At the fourth cowbarn two injections were given with 15 days' interval. The increase of the milk yield at the fourth cowbarn after both injections, as well as at the other barns lasted from 6 to 15 days.

Such irregularity is undoubtedly connected with individual properties of the cows, as well as with the feeding conditions in those cowbarns. The latter seems to be the main reason if we remember the conditions of additional feed at the fourth cowbarn.

Figure 1 shows the fluctuations of the milk yield at the fourth cowbarn 9 days before the injections and the milk yield after the first and second injections.

FIG. 1.   FLUCTUATION OF THE DAILY MILK YIELD OF THE TEST AND CONTROL GROUPS OF
COWS AT COWBARN NO. 4 (EXPRESSED AS PERCENTAGE).   THE AVERAGE MILK
YIELD DURING THE PRELIMINARY PERIOD IS TAKEN AS 100 PER CENT.

If the average milk yield at this cowbarn 9 days before the injections amounted to 1508 l. per day (within the limits 1417–1594 l.) the daily increase of the milk yield in days following the first injection amounted to 350 l., 440 l., 168 l., 101.5 l., 105 l. and then less (Table 8).   Expressed as a percentage, the milk yield after injection amounted to (if the average daily milk yield at the cowbarn before the injection is taken at 100 per cent) 123.2 per cent, 129 per cent, 122.5 per cent, 111.1 per cent, 106.8 per cent, etc.   The daily milk yield at that cowbarn before injection varied from 93.9 to 105.7 per cent.   We see a similar picture at the fourth cowbarn after the second injection as well (table 8).

TABLE 8
Daily increase of milk yield after injection (in liters)

COW-BARN NO.	AV. DAILY MILK YIELD PER COWBARN (PRELIM. PERIOD)	INJECTION	DAYS											TOTAL
			1	2	3	4	5	6	7	8	9	10		
4	1508	1st.	350	440	340	168	101	105	65	62	37	45	253 11–15th day	3872
		2nd	307	419	344	284	196	118	82	59	13	21	63 11–12th day	... ..
2	1210	... ...	274	293	233	145	66	60	52	. .	. . .		....	1123
3	1567	......	226	377	300	183	181	148	65	28	54	... ..	... .	1562
5	1240	.. ..	249	266	242	193	102	76	. ....	......	......	......	....	1118
In all	.. ..	. .. .	. . ..	....	....	....	.. ..	....	......	......	......	......	....	7675

The fluctuations in the milk yield of the control group were insignificant. The total quantity of additional milk produced at the fourth cowbarn (by 138 cows) amounted to 3871 l.

The same trend is observed at the other cowbarns (Figs. 2, 3 and 4, Table 8). Expressed as percentage, the daily increase of the milk yield at the second cowbarn in cows receiving injections of the preparation amounted
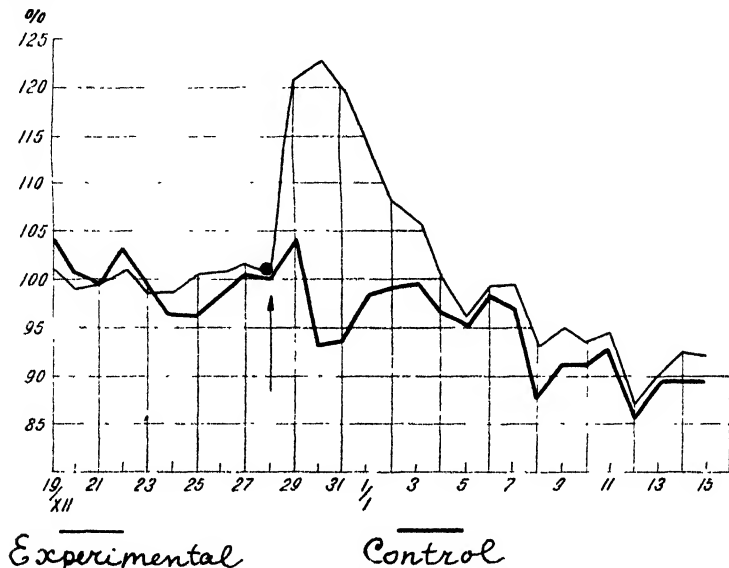
FIG. 2. FLUCTUATION OF THE DAILY MILK YIELD OF THE TEST AND CONTROL GROUPS OF COWS AT COWBARN NO. 2 (EXPRESSED AS PERCENTAGE). THE AVERAGE MILK YIELD DURING THE PRELIMINARY PERIOD IS TAKEN AS 100 PER CENT.

to 122.6 per cent, 124.2 per cent, 119.3 per cent, 112.0 per cent, 105.4 per cent, and less; the fluctuations in the milk yield of the control group did not rise above 101.0 per cent (here also the average daily milk yield for the preliminary period was taken as 100 per cent). The total additional quantity of milk produced by giving injections of the preparation at the second cowbarn (by 115 cows) amounted to 1123 l.

At the third cowbarn the milk yield after injections was as follows: 114.4 per cent, 124 per cent, 119.1 per cent, 111.6 per cent, 111.5 per cent, 109.3 per cent, 103.9 per cent, etc. Before the injections the milk yield in this group of cows did not rise above 101.8 per cent (as compared with the average daily milk yield taken as 100 per cent). The milk yield in the control group of cows did not rise during the test period above 102.5 per cent. Total quantity of additional milk at the third cowbarn (from 154 cows)—was 1562 l.

Experimental   Control
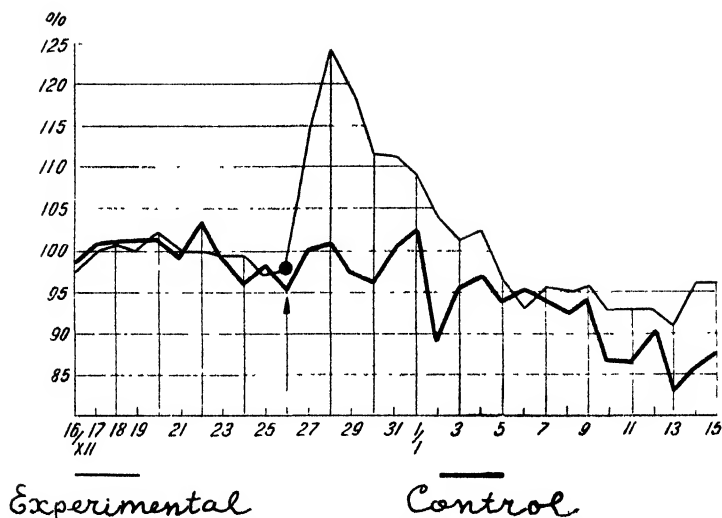
FIG. 3.   FLUCTUATION OF THE DAILY MILK YIELD OF THE TEST AND CONTROL GROUPS OF
COWS AT COWBARN NO. 3 (EXPRESSED AS PERCENTAGE).   THE AVERAGE MILK
YIELD DURING THE PRELIMINARY PERIOD IS TAKEN AS 100 PER CENT.

At the fifth cowbarn after injection the cows of the test group gave
120.1 per cent, 121.5 per cent, 119.5 per cent, 114.8 per cent, 108.2 per cent,

Experimental   Control
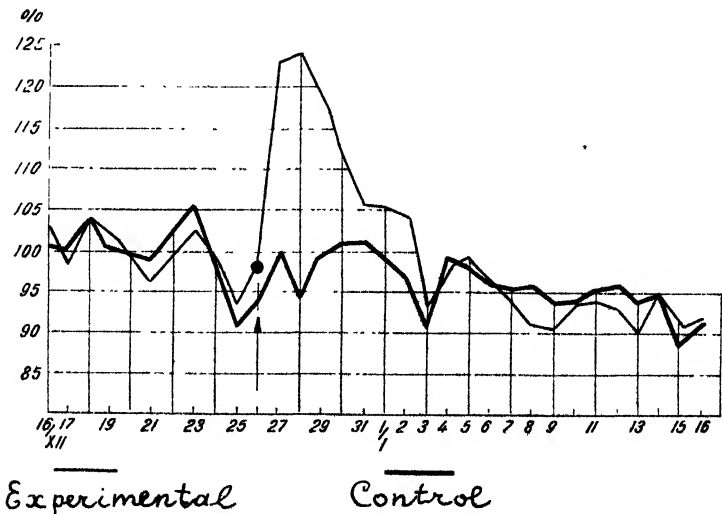
FIG. 4.   FLUCTUATION OF THE DAILY MILK YIELD OF THE TEST AND CONTROL GROUPS OF
COWS AT COWBARN NO. 5 (EXPRESSED AS PERCENTAGE).   THE AVERAGE MILK
YIELD DURING THE PRELIMINARY PERIOD IS TAKEN AS 100 PER CENT.

106.0 per cent (compared with the preliminary period). Total quantity of additional milk at the fifth cowbarn (from 103 cows)—1118 l.

As a result of the injections of the preparation from the anterior pituitary 510 cows gave 7675 l. of additional milk above the quantity which those cows would have produced without the injections.

The above-mentioned data show clearly that a notable increase in the milk yield was obtained only from cows which were given injections. The control group produced only a negligible quantity of additional milk. The data also make it clear that the additional quantity of milk is produced in the main not as a result of additional feeding. Two facts support this contention: (1) In spite of continued additional feeding the cows cease to give an increased milk yield after the injected preparation has ceased to act ; (2) In spite of received additional feed the control group of cows did not increase the milk yield to any marked extent.

<div align="center">DISCUSSION</div>

First of all it is necessary to confront the following data. Each cow at cowbarn No. 4 gave on the average 14 l. of additional milk per one injection, at cowbarns No. 2, No. 3, and No. 5—9.8, 10.0, and 10.9 liters, respectively. The better results at cowbarn No. 4 can probably be explained by the better feeding conditions at that cowbarn compared with the other barns. This gives a certain reason for the conclusion that better keeping of cows favorably affects the results from injections of the lactogenic substances from the anterior pituitary.

We could confirm it also by a test carried out at another State Farm.

Individual cows respond differently to the injection of the preparation. Some cows do not react at all. At the fourth cowbarn there were four such cows. at the second 12, at the third 13, and at the fifth cowbarn four cows.

The duration of the increase of the milk yield varies with different cows. The condition at cowbarn No. 4 was as follows: After the first injection the increase lasted in 16.5 per cent of cows for 15 days, in 9 per cent for 7 days, in 11 per cent for 6 days, in 9.8 per cent for 3 days, etc.

After the second injection the increase lasted in 21.8 per cent of cows for 14 days, in 8.9 per cent for 12 days, in 10 per cent for 10 days, in 16.7 per cent for 8 days, in 9 per cent for 6 days. in 13 per cent for 5 days, in 9 per cent for 4 days, etc.

Thus at cowbarn No. 4 we had a considerable percentage of cows responding during a long period of time to the injection of the preparation from the anterior pituitary. About the same occurred at the other cowbarn with the exception that the action of the preparation only in exceptional cases lasted 14 or 15 days and was limited mostly from 7 to 10 days.

A considerable number of cows have responded to the injection of the preparation by a marked increase in the milk yield. Thus 75 per cent of

TABLE 9
Maximum increase of the daily milk yield

INCREASE OF THE YIELD (%)			IN THE FOLLOWING PERCENTAGE OF COWS			
			Cowbarn No. 4	Cowbarn No 2	Cowbarn No 3	Cowbarn No 5
0			2.9	10.4	8.4	3.9
From	1 to	10		0.9		0.9
"	11 "	20	6.5	16 5	15.6	18.1
"	21 "	30	21.8	27.8	36.4	30.5
"	31 "	40	34.0	20.0	17.0	32.4
"	41 "	50	19.6	15.6	12.3	9.5
"	51 "	60	6.6	5.2	3.9	2.9
"	61 "	70	4.3	0.9	3.9	0.9
"	71 "	80	1.5	1.8	1.9	0.9
"	81 "	90	0.7			
"	91 "	100	2.1	0.9		

experimental cows at the fourth cowbarn after each injection gave a 20 to 50 per cent increase in the milk yield. We speak naturally of the maximum increase in the daily milk yield (Table 9). The same is observed as at the other cowbarns. At the second cowbarn such an increase was given by 66 per cent of cows and at the 5th cowbarn by 72 per cent of cows. We see here again the same relation which has been already recorded by us: the better the feeding conditions are at the cowbarn (in our case the fourth), the greater percentage of cows responds by a larger increase of the milk yield. However at all the four cowbarns, as it is shown in Table 9, more than half of the cows responded to the injection of the preparation by a considerable increase of the daily milk yield. A certain number of cows increased the milk yield even more than by 50 per cent. A more vivid picture of the increase of the milk yield is given by Table 10.

We see here that at all the four cowbarns (but especially at the fourth) the milk yield of several cows has increased by four and more liters a day with three milkings.

Some cows are in this respect of exceptional interest. Cow No. 1172, Yaroslav, born in 1925, second month of pregnancy and fifth month of

TABLE 10
Cows with a large increase of the milk yield 4–5 liters

NUMBER OF COWBARN	DAILY INCREASE OF MILK YIELD					
	4–5 liters		5–6 liters		6–7 liters	
	Number of cows	Per cent	Number of cows	Per cent	Number of cows	Per cent
4	50	35.6	13	9.4	5	3.7
2	21	18.3	6	5.2	2	1.7
3	23	14.9	2	1.3		
5	13	12.6	3	2.9	1	0.9

lactation produced an average daily milk yield during nine days preliminary period of 13 l. On the first day after the first injection she gave 18 l., on the second day 19 l.; after the second injection 19.5 l. and 19.5 l. She maintained increased milk yield 15 days after the first injection (gave during that time 40.5 l. additional milk) and 14 days after the second injection gave during that time 57 l. additional milk. In all during 29 days cow No. 1172 gave 97.5 l. additional milk, with an average daily increase of 3.36 l. Cow No. 850, Yaroslav, born in 1924, 6th month of lactation, barren, produced an average daily milk yield during preliminary period of 10 l. On the first day after the first injection she gave 15 l., on the second day 14 l.; after the second injection she gave 15.5 and 14.5 l. She maintained increased milk yield after first injection for 15 days (36.5 l. of additional milk during that time); after the second injection for 14 days she gave 48 l. additional milk. In all during 29 days cow No. 850 gave 59 l. additional milk.

Cow No. 724, Kholmogor, born in 1928, fifth month of lactation and 3rd month of pregnancy (calved normally in June, 1936) produced an average daily milk yield during preliminary period of 11 l. After the first injection she gave daily 16 and 16.5 l.; after the second injection 14.5 and 15.5 l. She maintained increased milk yield after the first injection for 13 days (gave during that period additional 28 l.; after second injection for 14 days (gave
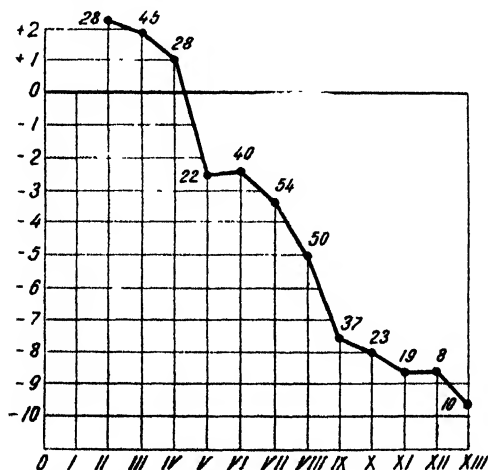
FIG. 5. AVERAGE DIFFERENCE BETWEEN THE MAXIMUM DAILY MILK YIELD AFTER CALVING AND AFTER INJECTIONS OF THE PREPARATION. ABOVE THE LINE IS SHOWN THE DIFFERENCE IN MILK YIELD, EXCEEDING THE MAXIMUM MILK YIELD OF COWS AFTER CALVING AS COMPARED WITH MILK YIELD AFTER INJECTIONS. FIGURES ON THE CURVE REPRESENT THE NUMBER OF COWS. ABSICCA REPRESENTS MONTHS OF LACTATION.

additional 27.5 l.).   In all during 27 days cow No. 724 gave 55 l. additional milk.

The following fact is of special interest.   We have computed average values for the increase of the milk yield of 364 cows, combining together animals from different cowbarns according to the months of lactation.   It appears that the later in the period of lactation the injection is made the less is the effect of increased milk yield.   Thus, if the injection during the second to fourth month of lactation can induce a rise in the milk yield exceeding the maximum daily milk yield of the cow after calving, an injection of the preparation given in the later months of lactation no longer produces the same effect (Fig. 5).   This fact is recorded by us not for the first time and was already explained ·in the sense that during the earlier months of lactation the mammary gland seems to be more "labile" and easier increases its secretory activity under the stimulating influence of the lactogenic substances from the hypophysis.

Leaving for the next communication a detailed analysis of the reasons why individual cows react differently to the injection of lactogenic preparation let us dwell in conclusion on the following questions directly connected with our experiment.

1. Some time ago we examined in a special test the quality of milk produced after the injection of lactogenic preparations.   Milk sugar, chlorine, acidity, chloro-sugar coefficient were quite normal.   The percentage of butterfat in several cases was slightly increased.   In the present experiment we have examined only the butterfat.   In 50 cows (45 experimental and 5 control) at the fourth cowbarn the butterfat was examined in the course of 6 days before the injection of lactogenic preparation and during 5 days after injection; fat determination was repeated at that barn after second injection as well.   It was found that the percentage of butterfat has risen after first injection in 12 cows and after second injection in 14 cows by 0.1 to 0.7 per cent (and on some days by 0.8 per cent).

However this rise of the fat percentage does not last long (2–3 days).   It is also necessary to point out, that the butterfat percentage has increased only in cows receiving *non-frozen* total preparation from the anterior pituitary.   This observation served as an incentive to detailed study of this question in which we are at present engaged.

2. Already before this test we have shown that our preparation is absolutely free from any harmful influence upon: (a) the course of lactation; (b) the development of the fetus; (c) the calving (there was not a single case of abortion attributable to the influence of lactogenic preparations); (d) the weight of new-born calves; (e) the next lactation; (f) the live-weight[2] of cows, etc.   This refers also to cases of repeated injections as well.

[2] Our observations show that in many cows the live weight even increases a little.

Thus observations of the results of injecting lactogenic preparations from the anterior pituitary have shown us that in spite of the stimulation of lactation and a considerable increase of the milk yield in some cows under the influence of lactogenic substances, the subsequent behavior of cows is normal in all respects. The injection of lactogenic preparations not only does not cause subsequent depression of lactation or "exhaustion" of the productive capacity of the cow, but, as it has been shown by observations, even retards in several cases a little longer the natural drop of the lactation curve.

3. Our experiments, and especially those described in the present communication (experiments of the application of lactogenic preparations on a larger scale), have shown that the maximum effect from those substances is produced under conditions of good feed regimen. But the use of lactogenic substances under such conditions is more effective because cows better nourished and kept on plentiful rations respond better to lactogenic stimuli than cattle kept under less favorable conditions. It follows that the injection of lactogenic preparations of the hypophysis may become one of practical measures applied at dairy farms.

The practical application of the lactogenic preparations from the anterior pituitary is in general more profitable on a well-run farm than on a farm with a poor food basis or where cattle are kept under unsatisfactory conditions.

4. In the summer of 1936 we carried out important experiments (on several hundreds of cattle) at a State Farm and at several Collective Dairy Farms in the Moscow region. On the whole this large scale experiment has produced results analogous to the results described in the present article. However it is necessary to point out that the use of lactogenic substances is slightly less effective in summer than in winter. After the change to stall-feeding the effect from the use of lactogenic substances rises again.

5. Preliminary calculations have shown that the cost of an injection of lactogenic substances from the hypophysis is very low. In any case the experiment on 600 cows described in the present communication (including 90 control animals, which also received additional concentrated feeds) brought a net profit of several thousand rubles after deducting all expenses.

The injection of lactogenic substances from the hypophysis serves our laboratory as one of the methods of studying the physiology of lactation in general. The question remains open—what mechanism increases the milk yield under the influence of lactogenic preparations from the hypophysis? Does the lactogenic preparation change the secretory activity of the mammary glands, does it influence the regulation of that process, or is, which is more probable, the lactogenic stimulus connected with both? All those are questions awaiting to be settled. At present we are studying those problems.

Thus the stimulation of lactation in the cow by the use of lactogenic preparations from the anterior pituitary is not simply getting from cows additional quantities of milk, but also a profound study of one of the still unrevealed physiological phenomena—lactation.

SUMMARY AND CONCLUSIONS

1. The experiment carried out at a State Farm on 600 head of cattle, including 90 control animals, has shown that the injection of lactogenic preparation (total preparation from the anterior pituitary) can produce a real and considerable although temporary increase of the milk yield.

2. A single injection of the lactogenic preparation to 372 cows and repeated injections to 138 cows resulted in 7675 liters of additional milk in a couple of days. The quality of milk remains normal. The percentage of butterfat slightly increases in a certain number of cases.

3. The tests with the lactogenic preparation of the hypophysis have proved the absolute harmlessness of those injections to the cow's organism and the absence of any undesirable after effects upon the productivity of the animals.

4. The injection of lactogenic substance from the hypophysis is more effective in well-kept cattle.

5. The injection of the lactogenic substances is more effective during the first half of lactation (2–6 months).

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OBSERVATIONS ON THE SALTING OF BRICK CHEESE

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The manufacture of Brick cheese is not as standardized a procedure as is the manufacture of some of the other well known types of cheese. The process is described by Thom and Fisk (1), Sammis (2), and Wilson and Price (3), but there appear to be differences of opinion among these writers concerning the methods of manufacture. Differences are even more noticeable when one observes factory processes. One of the most variable procedures in commercial practice is the operation of salting.

Brick cheese is commonly salted by rubbing dry salt on the outside of the cheese once each day for two or three consecutive days or by placing the cheese in a brine bath for a day or more. There is little uniformity in salting treatments among factories, either in respect to the time of salting, duration of salting, strength of brine or amount of salt, if dry salt is used. It is generally recognized that these treatments must influence the quality of the cheese although there is considerable confusion concerning the specific effects. It is the purpose of this paper to discuss the effects of some common variations in salting treatments.

Jackson and Morris (4) have investigated the effects of some variations in concentrations of brine for salting Brick cheese. They used concentrations ranging from 10 to 25% sodium chloride and pasteurized the solutions frequently to prevent bacterial spoilage. They concluded that brines containing less than 15% salt or more than 25% were not suitable; that the moisture content of the cheese decreased as the strength of the brine increased; and that a cooking temperature of 108° F. (42.2° C.) followed by salting for 48 hours in an 18 to 22% brine produced the most desirable quality.

Fleishman (5) in discussing the brine salting of Backsteinkäsen pointed out the necessity of clean brine tanks, careful regulation of salt concentration and temperature, and uniform exposure to the brine of all surfaces of the cheese. He indicated that dry salting tended to cause greater losses of moisture and required more time and labor than brine salting and also tended to affect unfavorably the uniformity of quality.

Mrozek (6) noticed when Limburger cheese was salted in 15% brine that there was a movement of salt into the cheese and that moisture was lost. Immediately after salting, the outer layers of the cheese were rich in salt and low in moisture. After one week, the salt content of the inner and outer layers were practically the same, but the moisture in the outer layers

was lower than at the center. Decomposition of the cheese during ripening caused marked hydration of the protein in the outer layers.

Koestler (7) called attention to the fact that when cheese was placed in a solution of sodium chloride containing more than 16% salt there was a loss of moisture from the outer portions of the cheese. This movement of moisture was reversed and an actual swelling or intake of moisture resulted when the cheese was placed in salt solutions of concentrations less than 16%.

Riddet, Valentine, McDowall and Whelan (8) studied the effect of salt on the quality of Cheddar cheese. They found that salting procedures must be varied to conform to the physical properties of the curd such as moisture content, acidity and rate of acid development. Under-salting resulted in the production of a cheese which was pasty and weak in body, which was open in texture and which did not ripen normally. Over-salting gave a cheese which was harsh in body, which ripened very slowly, and though the main portion of the cheese tended to be close in texture, the cheese rind often was badly cracked.

EXPERIMENTAL METHODS

Manufacturing Procedures

The manufacturing process used in these experiments followed most closely that described by Wilson and Price (3). A low-acid development was obtained by using only 0.1% of starter consisting of a mixture of half *S. lactis* and half *S. thermophilus* milk-grown cultures. Metal hoops instead of the usual wooden ones were used for sanitary reasons. Variations in the salting treatments will be described in connection with each experiment. ·

Temperatures and humidities maintained during salting and curing were somewhat low. The cheese was salted at 60° F. (15.6° C.). During the first two weeks of curing this same temperature was maintained with a humidity of 85%. The cheese was rubbed and washed every other day with a weak salt solution made by dissolving a handful of salt in a 12 quart pail of cold water. The cheese was paraffined at 14 days of age and placed in a curing cellar at 40° F. (4.4° C.) and at a relative humidity of 75%.

ANALYSES

Acidity measurements and tests for moisture and salt were made at definite intervals throughout the curd-making and ripening processes. The cheese was sampled by cutting the bricks in two at the center and removing a cross-section slice approximately 5″ x 3″ x ⅞″. The rind, to a depth of one-eighth of an inch was always discarded. The remainder of the slice was used for all analyses. Two more samples for analysis could be taken from the same brick by cutting each remaining half of the brick in two and removing slices in the same manner. When it was necessary to study the

rate of salt penetration, the usual slice of cheese was divided into four layers. The outermost layer of the rind was cut away to a depth of one-eighth of an inch and discarded. The next layer five-sixteenth inches in thickness was then removed and designated the "Outer" layer. A "Middle" layer was obtained by removing another layer of the same thickness. The remainder of the slice formed the "Center" portion. Deter-
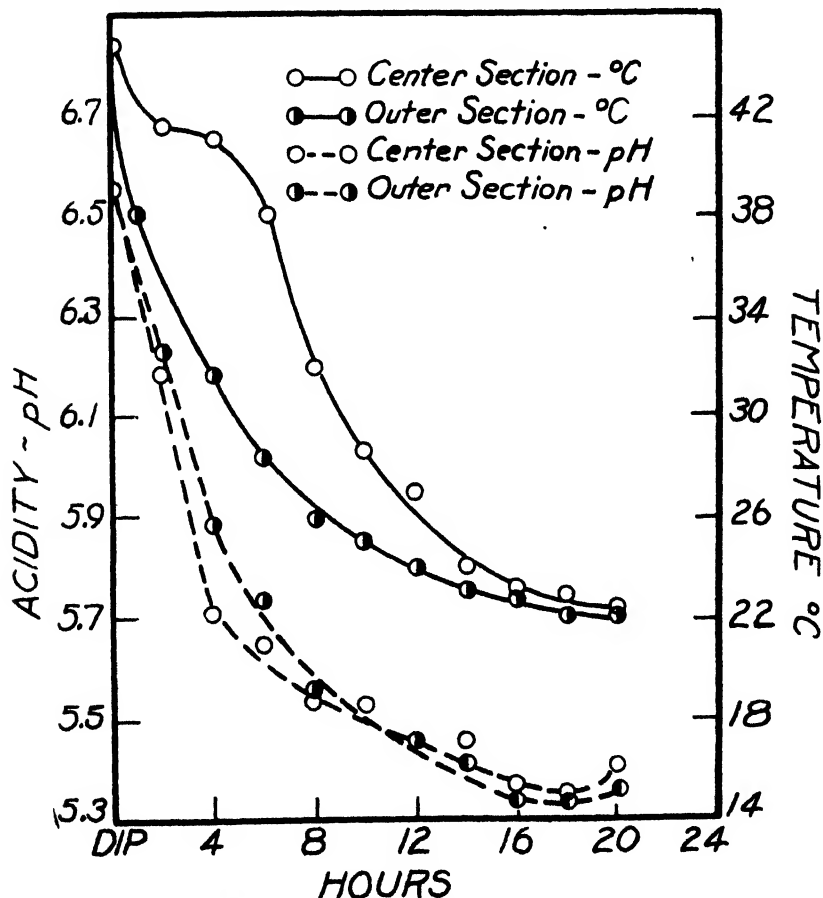
FIG. 1. THE RELATION BETWEEN TEMPERATURE AND CHANGES IN ACIDITY IN BRICK CHEESE DURING THE OPERATION OF DRAINING.

minations of pH were made with a Leeds-Northrup portable potentiometer, using the quinhydrone electrode. The amount of salt present was determined by titration according to the method described by McDowall and Whelan (9). Moisture tests were made by weighing about four grams of cheese in aluminum cups and drying at 100° C. for 24 hours at atmospheric

pressure, followed by one hour under a vacuum of at least 20 inches. The samples were then cooled in a desiccator and reweighed.

<div align="center">RESULTS</div>

<div align="center">*Observations on Changes in Cheese During Making and Salting*</div>

Eight lots of cheese were used to study changes in acid, moisture and salt during curd-making and curing. Milk selected from the same herd of cows was used for all eight lots. In this manner it was possible to follow a more uniform making process from day to day. Two of these eight lots are of special interest because measurements were made on one of them at intervals of 2 hours for a period of 20 hours after dipping; while similar observations were made on the second lot at intervals of 12 hours for 68 hours after dipping and then at intervals of 24 hours or more for 220 hours. The observations on the other six lots of cheese approximated so closely those which occurred in these two special lots that only these two lots will be used to illustrate the trends of early changes.

The composition of curd during the making of Brick cheese is determined by the interaction of a number of forces but chiefly those of temperature, acid and rennet effects. Figure 1 illustrates changes in temperature and acidity in the outer and center portions of a single loaf of cheese. While the temperature remained above 32 to 34° C. the acid development was rapid. Acid development decreased at temperatures below 30° C. and
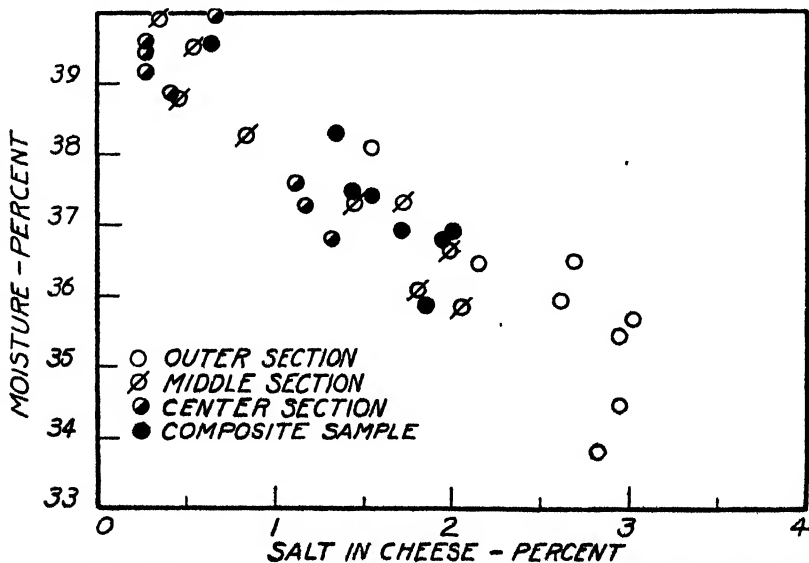
FIG. 2. THE RELATION BETWEEN THE MOISTURE AND SALT CONTENT OF BRICK CHEESE DURING THE FIRST WEEK OF CURING.

ceased after 18 hours when the temperature approximated 22° C. Differences in temperature and in acidity between the center and outer sections were greatest from four to six hours after dipping. At about the fourth hour after dipping, the rate of acid development of the center section decreased although the acidity of the outer section continued to increase fairly rapidly. At the tenth hour, both sections had the same acidity but after that time the acidity of the outer section was slightly greater than that of the center of the cheese.

The penetration of salt into the cheese is illustrated in Table 1. A 22%

TABLE 1

Salt penetration* in a single lot of Brick cheese

TIME AFTER DIPPING	SALT IN THREE SECTIONS OF CHEESE			SALT IN WHOLE CHEESE
	Outer	Middle	Center	
	Per cent	Per cent	Per cent	Per cent
32 hrs.	1.54	.34	.26	.63
44 hrs.	2.14	.43	.26	1.34
56 hrs.	2.62	.54	.26	1.54
68 hrs.	2.82	.83	.40	1.43
96 hrs.	2.94	1.45	.66	1.71
120 hrs.	2.94	1.71	.86	2.00
220 hrs.	2.65	2.05	1.31	1.85
1 mo.	2.68	2.62	2.34	2.59
3 mo.	2.54	2.59	2.62	2.56

* Salting began 20 hours after dipping. A 22 per cent sodium chloride brine was used.

sodium chloride brine was used and the cheese was placed in it 20 hours after dipping. At the time of salting the compositions of the various sections of the cheese were practically the same. The salt penetrated the cheese rapidly but not deeply. After 48 hours in the brine, the salt in the center section was only 0.4% although the salt in the outer section approximated its maximum value. The rate of diffusion of salt through the cheese seems to be a relatively slow process. The gradual increase in salt content of the whole cheese after the 68th hour, when the cheese was removed from the brine, may be accounted for by the use of weak brine solution for washing the cheese and by evaporation of moisture. The lot of cheese studied in Table 1 finally acquired more salt than was desirable. Slight irregularities in the data were caused by the necessity of analyzing different bricks of cheese in order to extend the period of observation.

An interesting fact concerning the relation between salt and moisture is illustrated in Figure 2. Each time the cheese or any section of it was analyzed for salt, the moisture content of the same sample was also measured. When the salt contents shown in Table 1 were plotted against moisture measurements it became evident that as the salt content increased the moisture in the cheese tended to decrease. This relationship agrees with

the observations of Jackson and Morris (4). The simple addition of salt would, of course, tend to decrease the percentage of moisture in the cheese. Calculations show, however, that the increase in salt could not alone account for the marked decrease in the moisture content of the cheese. Undoubtedly

TABLE 2

Influence of duration of salting in 22 per cent brine on the average acidity, moisture and salt content of three lots of Brick cheese

TIME OF ANALYSIS	ACIDITY			MOISTURE			SALT		
	Duration of salting			Duration of salting			Duration of salting		
	24 hr.	48 hr.	72 hr.	24 hr	48 hr.	72 hr.	24 hr.	48 hr	72 hr.
	pH	pH	pH	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Before salting	5.30	5.30	5.30	42.9	42.9	42.9	0	0	0
After salting	5.19	5.27	5.18	42.7	38.9	39.2	1.7	2.0	2.3
2 weeks	5.21	5.22	5.20	37.9	36.3	35.1	2.1	2.8	3.1
8 weeks	5.33	5.27	5.24	38.9	36.5	36.1	1.9	2.5	2.9

doubtedly the loss of moisture during the salting process must be attributed in part at least to the effect of the high osmotic pressure of the salt solution on the unsalted curd.

Influence of the duration of the salting treatment

The influence of the duration of the salting treatment was studied by dividing the cheese made from a single vat of mixed milk into three lots, one of which was salted for 24 hours, the second for 48 hours, and the third lot for 72 hours in 22% sodium chloride brine. This procedure was followed on three different days. The average of the measurements is shown in Table 2.

Acidity, as indicated by pH measurements, was not affected by the variations in the salting treatments to any marked extent. It is possible that the shortest period of salting might encourage an earlier breaking down of the protein. If this is true, then the slightly higher pH at 8 weeks of age in the cheese which was salted 24 hours might be regarded as evidence of this change.

The moisture content of all the lots decreased during the 8 weeks of observation. Those cheese in the lots salted for 48 and 72 hours lost more moisture than was desirable for the best ripening practices. Moisture content should be maintained at a level approximating 38% moisture to insure a moderately rapid ripening process. Slow ripening frequently results in the Cheddar type of flavor. This tendency was observed in the cheese salted for 72 hours.

The presence of salt may be expected to influence the ripening of the cheese, directly, through its influence on the biological agents themselves and, indirectly, through its influence on the physical properties of the curd,

such as moisture content and hardness of protein.   Examination of the data of Table 2 indicates the natural tendency for the salt to increase as the duration of the salting period was lengthened.   Increasing the salting period beyond 24 hours did not produce a proportionate increase in salt content. Apparently when the outer section of the cheese becomes highly salted then the increase in the salt content of the whole cheese depends upon the rate

TABLE 3

Effect of the duration of salting in 22 per cent brine on the average grade* of the cheese

CHARAC-TERISTIC	24 hours		48 hours		72 hours	
	Grade	Criticism	Grade	Criticism	Grade	Criticism
Flavor	3.5	Slightly unclean	3.7	Slightly unclean	3.7	Salty Unclean
Body	3.2	Fairly smooth	2.8	Fairly long	3.4	Firm
Texture	3.7	Open Gassy	3.5	Open Gassy	3.3	Medium close

* Key to grades: —1— Excellent   3—Satisfactory   5—Very objectionable
2—Desirable   4—Objectionable   6—Unsalable

TABLE 4

Influence of method of salting on the average acidity, moisture and salt content of three lots of Brick cheese

TIME OF ANALYSIS	ACIDITY			MOISTURE			SALT		
	Dry salt	22 Per cent brine	26 Per cent brine	Dry salt	22 Per cent brine	26 Per cent brine	Dry salt	22 Per cent brine	26 Per cent brine
	pH	pH	pH	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Before salting	5.33	5.33	5.33	41.5	41.5	41.5	0	0	0
After salting	5.16	5.17	5.22	39.8	39.1	38.8	1.6	2.1	2.2
2 weeks	5.19	5.22	5.19	37.0	35.7	35.4	2.2	2.7	2.7
8 weeks	5.36	5.30	5.30	36.1	36.0	32.3	1.4	2.4	2.7

of diffusion of the salt from the outside through the curd to the unsalted interior.   This is illustrated by the fact that although the salt contents of the outer sections in these lots of cheese were 2.9, 3.5, and 3.9% immediately after the 24, 48, and 72 hour salting periods, still the percentages of salt at the center of the cheese at the same time were only 0.5, 0.5, and 0.7%, respectively.

Table 3, which shows the average grades given these lots of cheese, indicates that each salting treatment tends to excel in its beneficial influence in some characteristic.   The shortest salting treatment produced the most desirable flavor; the 48 hour treatment developed the best body; and the 72 hour treatment induced the most desirable texture.   The long salting periods produced cheese which were criticized for salty flavor, hard body,

and unnaturally white color. These defects would be less acceptable as a general rule to the consumer than the open texture for which the 24 hour treatment was criticized. The milk used in these trials was not of superior quality, which not only lowered the general level of grades but emphasized the danger of using light salting treatments with gassy milk.

Influence of the method of salting

The influence of the method of salting was studied by dividing the cheese from a single vat of mixed milk into three lots, one of which was salted by rubbing with dry salt once each day for two days; the second by placing in 22% brine for 48 hours; and the third by salting in 26% brine for 48 hours. This procedure was followed on three different days.

The 22% brine was selected for these trials because weaker concentrations usually developed bacterial growth and offensive odors after a few weeks at 60° F. (15.6° C.). The 26% brine was selected because to maintain its strength it was only necessary to keep undissolved salt in the bottom of the brine tank. Partially saturated solutions of salt in brine tanks vary widely from the concentrations desired, according to measurements which have been made in various factories.

Acidity measurements of the cheese are shown in Table 4 and are practically identical to those shown in Table 3. They reveal no significant differences which might be attributed to the method of salting.

Moisture measurements, shown in Table 4, indicate the severity of the treatment in the 26% brine. The moisture decreased constantly until the last observation at 8 weeks of age. Such a treatment, if it induced these changes under all conditions, would be highly undesirable. In its effect on moisture the dry-salt treatment approximated salting in 22% brine for 48 hours except that the moisture was held a little more tenaciously by the dry-salted cheese.

Salt measurements shown in Table 4 indicate two significant facts: first, the dry salting treatment does not incorporate salt as fast as the brine treatments used in these experiments; and second, the dry salting treatment induces greater irregularity in the rate of salt incorporation. As would be expected, the cheese salted in the 26% brine contained more salt than did either of the other lots.

The quality of the cheese made in these experiments is shown by the average grades in Table 5. There were practically no differences in the flavor of the three lots of cheese. Dry-salting and salting in 22% brine produced better body. The 26% brine caused the cheese to be white in color and too firm or curdy in body even after 8 weeks of curing. The grades on texture indicate a slight advantage in dry salting. This is surprising in view of the fact that the milk was of such inferior quality that gas holes were formed in all lots of cheese. This might be explained, how-

ever, by some observations which were made on the fermentation of lactose in the cheese. Differences in the browning of curd during drying for moisture tests attracted attention to the possibility of differences in the lactose content. Sanders (10) has related the browning of cheese at 100° C to the lactose content and states that the intensity of color is proportional to the lactose present. By this browning test cheese which was dry salted showed little or no lactose present 68 hours after dipping while the brine salted

TABLE 5

Influence of method of salting on the average grade* of Brick cheese

CHARACTERISTIC	METHOD OF SALTING					
	Dry salting		48 hours in 20 per cent brine		48 hours in 20 per cent brine	
	Grade	Criticism	Grade	Criticism	Grade	Criticism
Flavor	3.2	Unclean	3.2	Unclean	3	Unclean
Body	2.8	Smooth	2.8	Slightly Curdy	2.0	Curdy
Texture	3.2	Open Grassy	3.6	Open Cracks	2.3	Open Grassy

* Key to grades —1 Excellent Satisfactory Very Objectionable
2 Desirable 4 Objectionable 6 —Unsalable

TABLE 6

The effect of salting at 4 hours and at 20 hours after dipping on the average acidity, moisture, and salt content of three lots of Brick cheese

TIME OF ANALYSIS	SALTED 4 HOURS AFTER DIPPING			SALTED 20 HOURS AFTER DIPPING		
	Acid	Moisture	Salt in cheese	Acid	Moisture	Salt in cheese
	pH	Per cent	Per cent	pH	Per cent	Per cent
Before salting	5.88	45.0	0	5.30	42.9	0
After salting	5.49	42.6	2.52	5.27	38.9	2.03
2 weeks	5.34	38.5	3.37	5.22	36.3	2.77
8 weeks	5.38	37.3	2.94	5.27	36.5	2.50

TABLE 7

Comparison of salting at 4 hours and at 20 hours after dipping on the penetration of salt into the cheese*

TIME BETWEEN DIPPING AND SALTING	SALT IN TWO SECTIONS OF CHEESE			SALT IN WHOLE CHEESE
	Outer	Center	Difference	
Analysis immediately after salting				
hours	Per cent	Per cent	Per cent	Per cent
4	4.09	.91	3.18	2.52
20	3.53	.53	3.00	2.03
Analysis two weeks after salting				
4	3.97	2.77	1.20	3.37
20	3.40	2.14	1.26	2.77

* Duration of salting was 48 hours for both lots

cheese often showed browning in the outer section of the cheese immediately after salting, but, as the cheese aged, the color induced by drying gradually became less evident and finally disappeared. The highest salt concentrations were always associated with the most intense brown color. It is possible that further work might indicate that the rapid fermentation of the lactose in the dry salted lots inhibited somewhat the undesirable types of fermentation.

The effect of early salting

It is a common procedure in factory practice when the curd is of doubtful or inferior quality to salt the cheese on the day of making. Perhaps this custom originated from the knowledge that salt applied to the rind of Swiss cheese during the curing process tends to suppress gas formation.

In order to determine the effect of this treatment a single lot of curd was divided into two parts. One half of the curd was placed in the molds, drained 20 hours, then salted for 48 hours in 22% brine. The rest of the curd was drained for 4 hours only and then placed in the 22% brine for 48 hours. These comparisons were made on three different days. The effects of the treatment are summarized in Tables 6 and 7.

Every characteristic of the cheese was affected by early salting. The acidity development was definitely and permanently checked by the treatment. The contrast between the acidity of the experimental and the control lots indicates the danger of salting curd too soon if acid is required to control abnormal fermentations. It is known that acid develops rapidly in the cheese for about eight hours after dipping and much more slowly after that time. Early salting, therefore, should probably take place no sooner than 8 hours after dipping if the normal acid development is to be approximated. The moisture content of the early-salted cheese was higher than that of the control cheese at every measurement. This might be predicted from the trends of acid development which have been described. The salt content of the early-salted cheese was higher than that of the control. This may be attributed to the fact that the curd is not knit together in such an impervious mass 4 hours after dipping as it is 20 hours after dipping. Whey still drains freely from it at 4 hours. It is natural, therefore, to expect a more rapid exchange of salt and moisture especially during the early stages of salting. This assumption is verified by measurements of salt penetration.

The penetration of salt is indicated in Table 7. The data are based on analyses of the outer and center layers of the cheese. It is apparent that the cheese salted 4 hours after dipping absorbed salt more rapidly than did the control lot of cheese. The differences between the salt in the outer and center layers are practically the same for both lots of cheese at the two intervals of analysis.

The effect of early salting on the quality of the cheese at 8 weeks of age is also interesting. The flavor of the experimental and control lots were practically identical. The body of the early-salted cheese was inclined to be curdy and hard and in these respects distinctly inferior to the control cheese. The texture of the early-salted lots was slightly closer than that of the control lots. The early-salting treatment, under the conditions established in these trials, failed to inhibit gas development since a few gas holes were found in both the experimental and control lots. It is significant to note that the browning test for lactose showed nearly as much lactose after 8 weeks of curing as was present when the cheese was placed in the brine tank. As a whole, the curd salted 4 hours after dipping produced cheese which was inferior to that made from identical curd which was salted 20 hours after dipping.

DISCUSSION

The concentration of brine and the duration of the salting treatment both influence the loss of moisture from Brick cheese during curing. Excessive loss of moisture injures the body of the cheese and decreases the yield. It is difficult to reduce these losses by decreasing the salt in the brine much below 22% because weaker concentrations tend to undergo bacterial spoilage. It is highly essential, therefore, that the duration of the salting treatment be carefully regulated.

Cheese salted in 22% brine solution for 24 hours contained about two per cent salt. This treatment produced desirable body and texture. It is suggested that a saturated brine solution might be used for salting the cheese if the time of exposure did not exceed 24 hours. The use of saturated brine would eliminate the problem of regulating an unsaturated salt solution and would increase the capacity of the brine tank because of the reduction in the duration of salting.

There are several conditions under which this suggestion might actually cause trouble for the maker if it were followed. (1) The size of the loaves of cheese are an important factor in determing the salt penetration. Loaves larger than about five pounds should be salted a little longer while thin loaves should be removed from the brine sooner. (2) The recommendations are based on the assumption that the cheese is washed on alternate days with a two per cent salt solution. If clear water is used, salt is removed from the surface of the cheese. This might be a desirable treatment, for example, when the characteristic surface smear is slow in appearing, or when the cheese is over-salted in the brine tank. Occasionally factories crowd cheese in the brine tank so that the brine contacts only a small portion of each cheese. Obviously, any treatment recommended must be based on the assumption that the brine tank is large enough to provide space for floating the cheese. Crowding effects can be minimized to a certain extent

by frequent turning of the cheese, by judicious use of dry salt on exposed surfaces or by placing a weighted rack over the cheese in order to submerge it in the brine.

SUMMARY

Brick cheese curd was made by a commonly used method and subjected to various salting treatments. Measurements of acidity, moisture and salt content were made at regular intervals and the cheese were graded.

Salt penetrated the cheese quickly in the outer layer but eight weeks of curing elapsed before the salt content was practically uniform throughout the cheese. Long periods in the salt tank, highly concentrated brines, and early-salting increased the amount of salt in the cheese. Dry-salting was effective but not as uniform as brine-salting.

Desirable results were obtained when the Brick cheese absorbed salt to the extent of approximately 2% of its total weight. Excessive salting caused hard, curdy body, unnatural white color, slow ripening, loss of yield, and delayed lactose fermentation; low salt encouraged abnormal fermentations and caused weak body and open texture.

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THE GAS REQUIREMENTS OF MOLDS—I

A PRELIMINARY REPORT ON THE GAS REQUIREMENTS OF[1] *PENICILLIUM ROQUEFORTI* (VARIOUS STRAINS OF BLUE MOLD FROM CHEESE)

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This study was undertaken to ascertain the gas requirements of several strains of *Penicillium roqueforti* at different temperatures. In a previous study (13) of methods to increase the mold growth in blue veined cheese, it was realized that the present knowledge of the reaction of molds to gases was not sufficiently advanced for progress to be made by direct application of gases to cheese.

Existing data (3), (10), (33), (36) indicate that, in all probability, there are several varieties or strains of blue mold that are responsible for the ripening of blue veined cheeses, such as Roquefort, Gorgonzola and Stilton. Biourge (3), in addition to the name *P. roqueforti*, used *P. gorgonzola* and *P. stilton*, though it is doubtful that they can always be differentiated morphologically. As this study is primarily physiological, it must be appreciated that the Penicillia of closely similar morphology may differ widely in their metabolism (1), (8), (10), (11), (12), (13). It is for these reasons that a large and varied number of cultures, probably different strains, of *P. roqueforti* have been used in this investigation.

It is well known that *P. roqueforti* and many other molds produce CO_2 when grown in an enclosed space (10) (35). Durrell (6) showed that CO_2 in amounts up to 5 per cent stimulated mold growth (*Basisporium gallarum*). Plaz *et al.* (30) indicate an atmosphere of 15 per cent CO_2, produced by plant tissue or by a gas generator, as optimum for germination of spores of *Ustilago zeae*.

The inhibiting effect of CO_2 on the fungi has been widely studied (4), (5), (22), (27), (30), (32), (35). Various species of mold show wide differences in this respect (35). The work, as a whole, is difficult to correlate closely because of variations in the media, humidity, temperature of incubation, and the stage of germination of spores. Thom and Currie (35) have shown that *P. roqueforti* was able to grow at room temperature, with only slight restriction, in an atmosphere of 75 per cent CO_2 and 5 per cent O_2, while 21 other species of Penicillia suffered greater inhibition. Brown (4) found that *P. expansum* could grow in relatively high CO_2 pressures, an observation in agreement with the work of Thom and Currie (35). Early work by Chapin

(5) showed that *P. glaucum*, an organism closely related to *P. roqueforti*, germinated in 90 per cent CO_2. These findings (4), (5), (35) are suggestive of the conclusion that, at room temperature, *P. roqueforti* and closely related strains are least inhibited by high concentrations of CO_2.

However, no molds grow in pure CO_2 (4) (5), but they are not killed (32) (34) and grow normally again when exposed to the air in suitable media and temperatures.

Brown (4) found that low temperatures increased the inhibiting power of CO_2 on the growth of mold and that the degree of inhibition was much more than could be accounted for by the greater solubility of CO_2 at the lower temperature. Other investigators (27), (32) also noted this property.

The media affect the growth of mold in concentrations of CO_2 which are partly inhibiting. Thus Brown (4) observed that a dilution of the nutrients retarded germination.   Skovholts (32), investigating the growth of molds on bread, in inhibiting concentrations of CO_2, at low temperatures, compares his work with that of Moran *et al.* (27) and finds that under similar conditions a lower concentration of CO_2 will inhibit mold growth on meat.   It would seem from other work (35) that the variety or strain of mold used could account for this difference.   When the low pH at which molds will grow (14) (21) and the small change in pH that CO_2 can make in the medium (30) are noted, it is doubtful that pH could be a significant factor.

Another phase of study is that dealing with the effect of O_2 on mold growth in the absence of CO_2, that is air at low or high pressure, or with N_2 or some other inert gas as the diluent.   Macy (24) working with 10 cultures of mold, 2 of which were Penicillia (*P. biforme* and *P. expansum*), shows that none of the molds grew on butter at room temperature when all the O_2 had been absorbed from the air by the alkaline pyrogallic acid reagent.   The same molds, with one exception, growing under the same conditions but without the oxygen absorbent and with the pressure reduced by 25 inches, grew slowly.   *P. expansum* showed the best growth and *P. biforme* grew as well as any of the other cultures.   When the experiment was repeated over a 10 per cent aqueous solution of NaOH, better growth was obtained.   Macy (24) states, "Apparently, a reduction in the amount of carbon dioxide does not seriously deter the growth of the species under observation."

Brown (4) shows that the amount of germination in a given time diminishes with increased concentration of O_2, but only very slowly, so that even in water quite a good germination results in 80 per cent O_2.   Again, as the O_2 pressure is diminished, no appreciable effect is shown until very low concentrations of O_2 (0.1 per cent) are reached.

Karsner and Saphir (23) find that concentrations of O_2 of 76 per cent and more exercise a definite inhibitory effect on certain molds.   In no case was the organism killed by the O_2 percentage employed, and on removal from the O_2 chamber, growth appeared to progress at a normal rate.   The

production of pigments by the molds is not altered by growth in any of the O_2 concentrations used.

Thom and Currie (35) show by analysis that the percentage of the gases of Roquefort cheese are CO_2, 21.14 to 40.95; O_2, 2.42 to 7.00; and N_2, 54.52 to 73.44. The last paragraph of their summary is as follows: "A mixture of 75 per cent of carbon dioxide with air gives approximately 5 per cent of free oxygen. The close correspondence between the results of gas analysis and comparative culture, indicates that the low percentage of oxygen in the open spaces within the cheese accounts for the dominant activity of *Penicillium roqueforti* in Roquefort and related types of cheese."

It is impossible to determine from the existing literature whether or not it is the low percentage of O_2 or the high percentage of CO_2 which is the chief limiting factor in the growth of mold in Roquefort cheese.

The early fermentation in the manufacture and ripening of Roquefort and other cheeses is of the lactic type (7), (29). *Streptococcus lactis* (2), (20) and varieties of this organism (19), (20) as well as *S. citrovorus* and *S. paracitrovorus* (18), have all been shown to produce CO_2 in the fermentation of milk and other media. One of the striking and uniform findings of these authorities (2), (18), (19), (20) is the wide variation in CO_2 production of different cultures grown under the same conditions. Not only the different species but also separate cultures of the same organisms (19) (20) vary in this respect.

Ayers *et al.* (2) working with the souring of milk by the streptococci found that there appear to be two varieties of *S. lactis*, A. and B., the first of which produces CO_2 and NH_3 from peptone, while the second does not. Variety A., according to their results, appears to be more prevalent. In commercial starters both varieties have been found; some have variety B.

Van Slyke and Hart (37), who ripened two cheeses so that the CO_2 production could be measured, showed that the normal cheese produced .5 per cent of its weight as CO_2, while the chloroformed cheese produced only a trace of this gas. The experiment demonstrates that practically all the CO_2 produced in the cheese ripening process is due to the growth of micro-organisms.

There are two recommendations as to the use of starters in Roquefort cheese making. Three recent publications (16), (17), (26) suggest the use of a good active starter to be used in relatively large quantities. The older French publication (25) does not mention the use of a starter but uses natural fermentation.

With the obvious possibility of controlling the production of CO_2 by fermentation in the making and ripening of Roquefort and other blue veined cheese, this study of the gas requirements of several strains of *P. roqueforti* was conducted.

CULTURES

The cultures of *P. roqueforti* used were mostly isolated from blue veined cheese, and are as follows:

ORIGIN OF CULTURES

Number of Cultures	Origin
1	*P. roqueforti* supplied by Dr. C. Thom about 1920.
15	Isolated from a Wensleydale Cheese made at the University of British Columbia.
16	" "
32	" "
33	" "
34	Isolated from a Wensleydale Cheese made by Rowntree, York, England.
37	" "
41	Isolated from a French Roquefort Cheese (Brand Civille).
43	Isolated from a N. K. Jensen mold powder supplied for inoculating Roquefort Cheese. (Imported from Denmark.)
3	Iowa Agr. Exp. Sta. Mold Culture No. 3 isolated from Danish Blue Cheese.
8	Iowa Agr. Exp. Sta. Mold Culture No. 8 isolated from French Roquefort Cheese.

Note: Cultures 3 and 8 were kindly supplied by Dr. B. W. Hammer, (38), (39).

Morphological and cultural studies of several of these cultures have been previously reported (8), (9), (10), (11), (12), (13), (14). As these cultures have been carried in stock for a number of years on malt agar slants, they were plated 3 times, a typical single colony being selected each time. Cultures 3 and 8, which were received from Dr. B. W. Hammer, were plated once. In the process of plating, contamination in the cultures was not observed. Incubation of the transfers was done at room temperature. Cultures of about one week of age were used to prepare water blanks with which to inoculate the plates.

MEDIA AND INCUBATION

Malt Agar: The malt agar used was the standard Difco product prepared as directed. The reaction was not changed.

Whey Agar: 5000 grams of sweet skim milk was renneted with 1 ml. of Hansen's rennet at about 90° F. (32.2° C.), and allowed to stand until well clotted. It was then cut with a knife and cooked by standing in water at about 120° F. (48.9° C.). The whey was drained off and agar added to the extent of 1½ per cent. The whole was heated in a steamer for 1 hour to dissolve the agar, then cooled to about 122° F. (50° C.) and the whites of 2 eggs added to 2000 ml. of media. The medium was then autoclaved and filtered.

Synthetic Media: For the 3 synthetic media the modified Czapek's salt solution as given by Naylor *et al.* (28) was used, plus the organic nutrients. The casein was put into solution with NaOH and adjusted to a reaction of pH 6.5 to 6.7 with HCl.

The media used were:

    a. Salt solution with 3 per cent casein (impure). $1\frac{1}{2}$ per cent agar.

    b. Salt solution with 3 per cent casein (impure) and 1 per cent lactose. $1\frac{1}{2}$ per cent agar.

    c. Salt solution with 3 per cent peptone. $1\frac{1}{2}$ per cent agar.

Preparation of Plates: To maintain uniformity between plates, 25 ml. of media were measured into 125 ml. Erlenmeyer flasks, plugged and sterilized at 15 lbs. for 30 minutes. The flasks were cooled somewhat and then the media poured on to sterile plates. By this method a thick uniform layer of medium was obtained. After the media solidified, wherever condensation of water on the lid of the petri dish was heavy, the lids were changed to prevent spreading the mold after inoculation.

Inoculation of Plates: A heavy loop of inoculum was transferred from the agar slant to a 100 ml. water blank and shaken well. One 2.5 mm. wire loop full of this aqueous dispersion of spores was used for inoculating the center of each plate.

Incubators: Special incubators which had sources of both heat and cold were used, so that a wide range of uniform temperatures was available.

> Note: The range of temperature given in the tables is wide because the maximum and minimum readings for the experiment were recorded. Thus a 48° F. (8.9° C.) compartment opened only for a few seconds on a hot summer day will rise several degrees. Trials with self-recording thermographs show the temperature to be very uniform.

GASES USED

Carbon Dioxide: CO_2 was used from a commercial cylinder of the gas, which contained over 99.8 per cent of gas soluble in NaOH.*

Carbon Dioxide	99.80%
Carbon Monoxide	Trace
Oxygen	Trace
Nitrogen	00.15%
Moisture	00.03%

Nitrogen: N_2 was used from a commercial cylinder of the gas, which contained less than 0.2 per cent of CO_2 and 0.2 per cent O_2. The same cylinders were used for all experiments.

  * Note: The Washington Liquid Gas Company give their certified analysis over a time of several years as follows:

Gas Chambers: 250 mm. Pyrex vacuum desiccators were used for growing the molds in the restricted air supply. By the use of wood blocks, it was possible to have each desiccator hold 22 plates each; *i.e.*, duplicates of the 11 cultures. It was found that the desiccators when properly greased maintained a very good vacuum. Controls were kept in tin trays.

Adding and Changing Gases: The desiccators, having been filled with the required inoculated plates, were evacuated to reduce the content of the air to the required fraction. The reduced pressure was measured with a manometer. The required gas was then added to the desiccator until atmospheric pressure was reached.

Example: Required, a mixture of 1 part of air to 3 parts of CO_2. Barometer pressure 700 mm. The desiccator was evacuated to a column of mercury of $\frac{700 \times 3}{4} = 525$ mm. CO_2 was then added to atmospheric pressure.

With the exception of the last experiment a daily change of gases was made. The method consisted in daily removing the lid of the desiccator, placing a tube to the bottom of the desiccator and sucking the air out for 3 minutes. The lid was placed on the desiccator which was then evacuated twice to 500 mm. each time, allowing air to enter at atmospheric pressure. Finally the chamber was evacuated to the calculated pressure and filled with the required gas.

It is not likely that the gas in the desiccator would remain constant for 24 hours, because of the growth of the mold, but the change in composition would be relatively slight, and the O_2 content would always tend to diminish rather than to increase.

Only in the last experiment were the gases adjusted as above but not changed.

MEASUREMENT OF COLONY

Whenever possible, the growth of the colony of mold was expressed in mm. which is the average diameter of 2 or more colonies, except those measurements marked * which were obtained from one colony. The difference between plates of the same culture of mold growth under the same conditions and for the same length of time usually did not exceed 2 to 3 mm. and in many cases they were identical. On poor media greater differences were sometimes observed.

Mathematical Expression of Growth Relationship: In all cases x has been used to represent the diameter of the control cultures in mm., y that of cultures grown in air diluted with CO_2 and z in air diluted with N_2. If the ratios $\frac{x}{y}$ or $\frac{x}{z}$ are greater than 1.0, growth in the experimental chamber is less than that in the control, and vice versa. Thus, when a culture grows to a diameter of 34 mm. in the air (control), and a diameter of 8.5 mm. in the

experimental culture with one part of air to 3 parts of CO_2 all other conditions being the same,

$$\frac{x}{y} = \frac{34}{8.5} = 4$$

Gas Analysis: Gas analysis was made with a William's gas analysis apparatus, which was accurate to 0.2 per cent.

Criticism of Methods: It is seldom that any biological measurement can be extremely accurate, and it therefore seems desirable to indicate one or 2 variables, which are beyond control in this study. A colony of mold growing on a medium in a petri dish never increases its diameter at a uniform rate. Also the greater the growth, the more pronounced will be the effect of the products of growth in depressing the rate of growth. Thus, in the last example where x = 34 mm. and y = 8 5 mm. in 5 days, in 7 days the restricted colony has a better chance to grow than the control, whose media is affected by more products of growth. Therefore, for the sake of comparison, an effort has been made to have the controls for each culture as uniform in size as possible. In several cases, measurements of young cultures are given for comparison.

TABLE I

Growth of strains of P. roqueforti in air and in air and CO_2 (1 to 3) at various temperatures

Approximate gas composition: 75% CO_2, 5.2% O_2, and 19.8% inert gas.
Media: Malt Agar.

Temperature of growth:	48° F. (8.9° C.)		70° F. (21.1° C.)			85° F. (29.6° C.)		
Temperature range:	42° F. to 52° F.		67° F. to 72° F.			83° F. to 86° F.		
Days growth:	14		5			4		
Culture:	x	y	x	y	$\frac{x}{y}$	x	y	$\frac{x}{y}$
1	36.5	No growth	42.5	20	2.13	27.5	6	4.58
15	26.5	" "	27.5	10	2.75	26	6	4.33
16	38	" "	43	17	2.53	25.5	6	4.25
32	37	" "	41.5	15.5	2.68	27	7	3.86
33	34	" "	39	16	2.44	24	6	4.00
34	38	" "	41.5	16.5	2.52	29	6	4.83
37	32.5	" "	34	8.5	4.00	17	Trace	
41	39	" "	45	22	2.05	31	Trace	
43	37.5	" "	30.5	18	1.69	26	6	4.33
3	39	" "	35*	20	1.75	22.5	Trace	
8	32.5	Trace	40*	16	2.50	30	7	4.29
Average	35.5		38.1	16.3	2.46	26		

x = Control diameter of colony in mm. of culture grown in air.

y = Diameter of colony in mm. of culture grown in 1 part of air to 3 parts of CO_2.

* Measurement from one colony.

Note: Mr. H. Fallscheer, Research Dairy Chemist, kindly made the gas analyses.

EXPERIMENTAL

The Effect of CO_2 on the Growth of P. roqueforti at Various Temperatures

In Tables I and II and Figs. 1, 2, and 3, the effects of 1 part of air to 3 parts of CO_2 (approximately 75 per cent CO_2, 5.2 per cent O_2 and 19.8 per cent inert gas) on the growth of *P. roqueforti* on malt agar at various temperatures are given. It has not been possible to give the relation of $\frac{x}{y}$ at 48° F. (8.9° C.), and with the small size of y at 85° F. (29.4° C.), it is doubtful whether or not the determination of $\frac{x}{y}$ has more than a general significance. The method at 85° F. (29.4° C.) is subject to some question particularly at the 7 day period, as there was considerable dehydration of the medium, which, because of the variable fit of petri dish lids, cannot be uniform.

TABLE II

Growth of strains of P. roqueforti in air and in air and CO_2 (1 to 3) at various temperatures

Approximate gas composition: 75% CO_2, 5.2% O_2, and 19.8% inert gas.
Media: Malt Agar.

Temperature of growth:	48° F. (8.9° C.)		70° F. (21.1° C.)			85° F. (29.6° C.)		
Temperature range:	42° F. to 52° F.		67° F. to 72° F.			83° F. to 86° F.		
Days growth	22		7			7		
Culture:	x	y	x	y	$\frac{x}{y}$	x	y	$\frac{x}{y}$
1	57	Slight growth	62.5	35	1.79	45.0	8.5	5.29
15	37	Just visible	44	20.5	2.15	42.5	9.5	4.47
16	56	Just visible	72	32.5	2.22	42.5	12	3.54
32	52	Just visible	57.5	31	1.86	39.5	14	2.82
33	49.5	Slight	57.5	34.5	1.67	35	10	3.50
34	52.5	Slight	66	32.5	2.03	41	8.5	4.82
37	42	Just visible	50.5	15.5	3.26	32.5	Trace	
41	60	No growth	67.5	42	1.61	47.5	Trace	
43	46.5	Just visible	45	35	1.29	42.5	8.5	5.00
3	51*	Just visible	54*	26.5	2.04	36.5	Trace	
8	47*	Just visible	62*	34	1.82	41.5	10.5	3.95
Average	50.1		58.1	30.8	1.97	40.6		4.18

x = Control diameter of colony in mm. of culture grown in air.

y = Diameter of colony in mm. of culture grown in 1 part of air to 3 parts CO_2.

All plates with the exception of Culture 41 showed definite growth of mold when held in air at 70° F. after the experiment.

* Measurement from one colony.

Tables I and II, for the 5 and 7 day period show:

(1) All controls grew normally.

(2) In all cases and at all temperatures CO_2 inhibited the growth of *P. roqueforti.*

(3) Temperature was a most important factor in inhibiting the growth of *P. roqueforti* in the presence of 1 part of air to 3 parts of CO_2.

    (a) At 70° F. (21.1° C.) the average inhibiting effect of CO_2 on the growth of the cultures studied was such that the colonies were less than half the size of the controls at 5 days' growth and about half the size of the controls at 7 days' growth. Fig. 1. The average values for $\frac{x}{y}$ at 5 and 7 days' growth were 2.46 and 1.97, respectively. There was considerable variation between cultures.

    (b) At 85° F. (29.4° C.) the inhibiting effect of CO_2 on the cultures studied was greater, little more than germination being recorded in many cases. Fig. 2. The average value for $\frac{x}{y}$ was between 4 and 5.

    (c) At 48° F. (8.9° C.) the inhibiting effect of CO_2 was almost complete. Fig. 3.

(4) The variation between strains was considerable and will be discussed in a later paper.

The Effect of Higher Concentrations of CO_2 on the Growth of P. roqueforti at 70° F. (21.1° C.)

Table III gives the effect of 1 part of air to 6 parts of CO_2 on the growth of *P. roqueforti* on malt agar at 70° F. (21.1° C.). After the repetition of the work given in Table I and II, at 70° F. (21.1° C.) and 48° F. (8.9° C.), with substantially the same results, it was decided to increase the concentration of CO_2 at room temperature as an additional check. The results are given in Table III and show:

(1) Duplicate determinations run at different times checked quite closely.

(2) Greater concentrations of CO_2 did not reduce the growth of the cultures in the same proportion as might be expected. The average values for $\frac{x}{y}$ at 7 days' growth were:

1 part of air to 3 parts of CO_2 1.97   Table II
1 part of air to 6 parts of CO_2 2.36   Table III

(3) The differences between strains were consistent.

The Effect of Concentrations of CO_2 on the Growth of P. roqueforti after Germination at 48° F. (8.9° C.)

As no significant growth could be obtained at 48° F. (8.9° C.) in 1 part

Control air   1 part of air   1 part of air
              to 3 parts of N₂   to 3 parts of CO₂
Fig. 1.   The effect of N₂ and CO₂ on the growth of *P. roqueforti*
                        at 70° F. (21.1° C.)
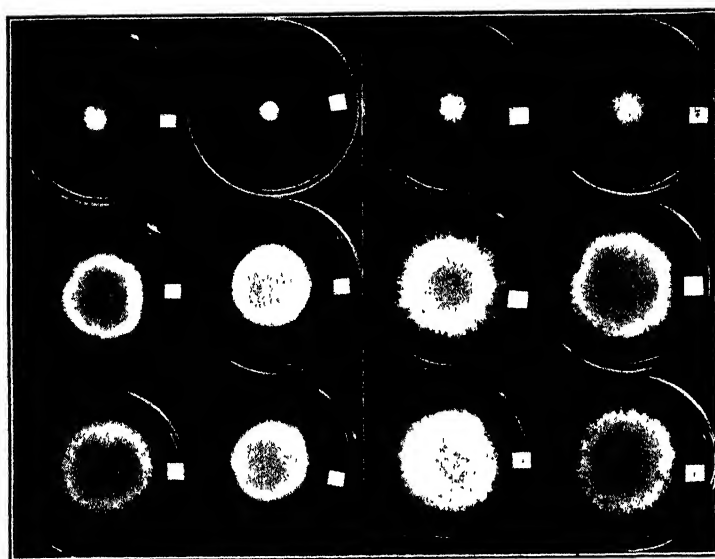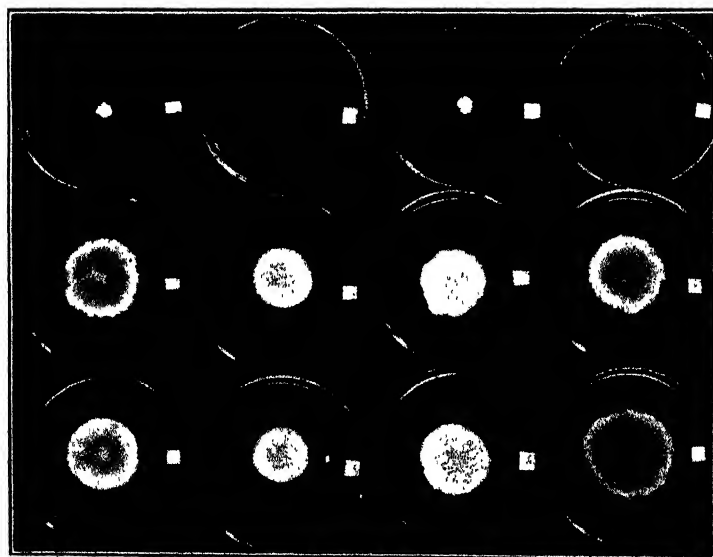
Control air   1 part of air   1 part of air
              to 3 parts of N₂   to 3 parts of CO₂
Fig. 2.   The effect of N₂ and CO₂ on the growth of *P. roqueforti*
                        at 85° F. (29.4° C.)
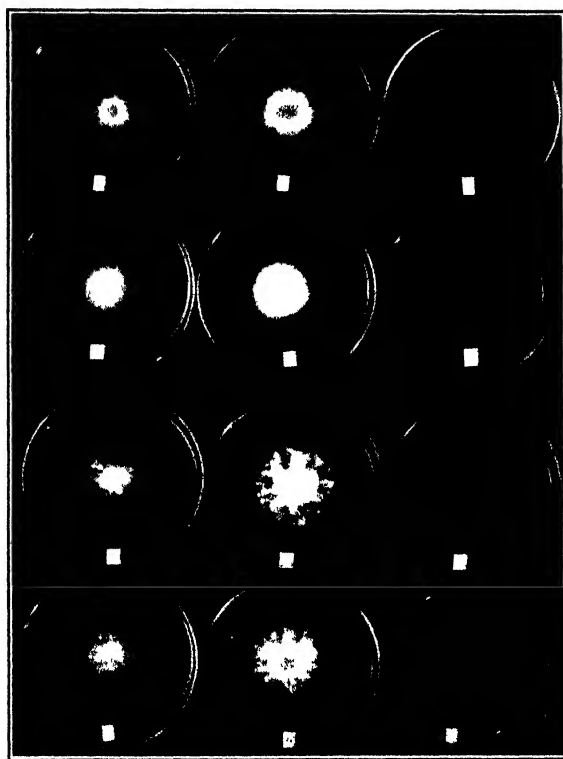
| | 1 part of air | 1 part of air |
| Control air | to 3 parts of N₂ | to 3 parts of CO₂ |

FIG. 3. The effect of N₂ and CO₂ on the growth of *P. roqueforti* at 48° F. (8.9° C.)

of air to 3 parts of CO₂, the inoculations on the plates were first germinated and grown to a small colony between 9 and 16 mm. in diameter, which required 48 hours at 70° F. (21.1° C.). Table IV. Column b. The experiment was then continued as in Tables I and II.

The results are given in Table IV and show:

(1) There was little or no increase in diameter of the colonies grown in 1 part of air to 3 parts of CO₂ in a period of 14 days. The controls grew normally.

(2) From this and the previous tables, it would appear that the inhibiting effect of CO₂ is about the same for germination and growth. In addition the appearance of the colonies grown in 1 part of air to 3 parts of CO₂ was quite different from that of the controls. The colonies were white in color and had a floccose growth more like *P. camemberti* than *P. roqueforti.* After a few hours in air

TABLE III
Growth of strains of P. roqueforti in air and in air and CO_2 (1 to 6) at 70 F.

Approximate gas composition: 84.8% CO_2, 3.0% O_2, and 12.2% inert gas.
Media: Malt Agar.
Temperature of growth: 70° F. (21.1° C.)
Temperature range: 66° F. to 72° F.
Days growth: 7   7

Cultures:	x	y	$\dfrac{x}{y}$	x	y	$\dfrac{x}{y}$
1	56	26.5	2.11	57	26.5	2.15
15	45.5	16	2.84	44.5	15.5	2.87
16	61.5	25.5	2.41	66	26.5	2.49
32	58	24.5	2.36	56.5	21.5	2.63
33	58.5	27	2.17	50	25.5	2 35
34	66	22.5	2.93	65	22.5	2.89
37	49	15	3.27	48.5	14.5	3.35
41	56	29.5	1.90	54	29.5	1.93
43	44.5	27.5	1.62	45*	25.5	1.76
3	52	23.5	2.21	52.5	21.5	2.44
8	59.5	28	2.13			
Average	55.1	24.1	2.36	54.9	22.9	2.48

x = Control diameter of colony in mm. of cultures grown in air.
y = Diameter of colony in mm. of cultures grown in 1 part of air to 6 parts of CO_2.
* Measurement from one colony.

at room temperature, the colonies took on their characteristic blue green color.

The Effect of CO_2 on the Growth of P. roqueforti, Different Media Being Used

To establish the general inhibiting effect of CO_2, different media must be used. A set of 10 strains of *P. roqueforti* was grown on whey agar, and also 4 selected cultures on 3 synthetic media. It is to be expected from previous work (10) (11) (12) that the culture strains used would vary with media, but it was hoped that the general trend could be determined.

Table V, with the exception of the medium, is comparable to Table III and shows:

   (1)   The general trend of growth inhibition by 1 part of air to 6 parts of CO_2 was of the same magnitude.

   (2)   Certain cultures, for example 3 and 15, deviated widely in their $\dfrac{x}{y}$ values from the results with malt agar. The difference was in part due to their finding whey agar a better medium for growth, as is shown by the controls.

Table VI and Figs. 4 and 5 show the effect of 1 part of air to 3 parts of CO_2 at 48° F. (8.9° C.) and 70° F. (21.1° C.) on 3 synthetic media.

TABLE IV

Growth of strains of P. roqueforti in air and in air and CO_2 (1 to 3) at 48° F. after a germination period of 2 days at 70° F.

Approximate gas composition: 75% CO_2, 5.2% O_2, and 19.8% inert gas.
Media: Malt Agar.
Temperature of growth: 48° F. (8.9° C.)
Temperature range: 44° F. to 50° F.
Days growth after
  germination: 14

Culture:	Control			1 part of air to 3 parts of CO_2		
	a	b	a − b	a	b	a − b
1	69	13	56	15	13	2
15	53	12	41	13	11	2
16	81.5	16	65.5	17.5	16	1.5
32	76.5	14	62.5	14.5	13	1.5
33	69	14	55	15.5	14.5	1
34	72	12	60	12	10.5	1.5
37	57.5	10.5	47	12	10.5	1.5
41	79.5	14	65.5	13	12	1
43	66.5	14.5	52	13.5	13.5	−
3	58.5	9	49.5	13	10	3
8	75	13.5	61.5	16.5	13.5	3
Average	68.9	13.0	56.0	14.1	12.5	1.6

a = Diameter of colony at the end of 14 days growth.

b = Diameter of colony after germination period.

Remarks: The mold growth in 1 part of air to 3 parts of CO_2 had the appearance of *P. camemberti*, being both white in color and floccose. After a few hours in air at room temperature the colonies took on their characteristic blue green color.

TABLE V

Growth of strains of P. roqueforti in air and in air and CO_2 (1 to 6) at 70° F.

Approximate gas composition: 84.8% CO_2, 3.0% O_2, and 12.2% inert gas.
Media: Whey Agar.
Temperature of growth: 70° F. (21.1° C.)
Temperature range: 67° F. to 72° F.
Days growth: 7

Culture:	x	y	$\frac{x}{y}$
1	59	27	2.19
15	52.5	13.5	3.89
16	66	23.5	2.81
32	61	19.5	3.13
33	59.5	26.5	2.25
34	69	20	3.45
37	67.5	18	3.75
41	56.5	27.5	2.06
43	41.5	24	1.73
3	41	24	1.71
Average	57.4	22.4	2.69

x = Control diameter of colony in mm. of culture grown in air.

y = Diameter of colony in mm. of cultures grown in 1 part of air to 6 parts of CO_2.

Media

3% Casein

3% Casein
and
1% Lactose
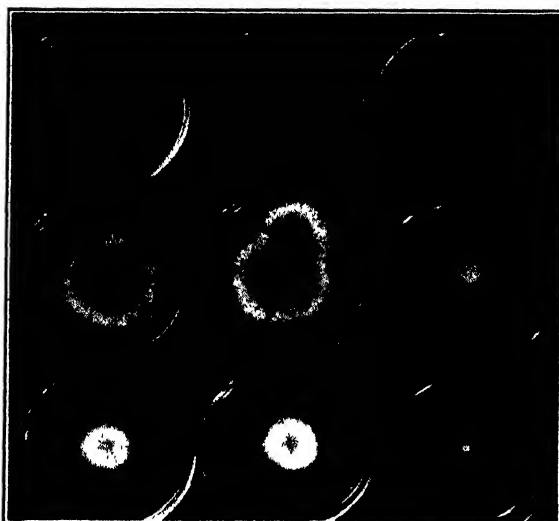
3% Peptone

Control air   1 part of air   1 part of air
to 3 parts of N₂   to 3 parts of CO₂

FIG. 4.   The effect of N₂ and CO₂ on the growth of *P. roqueforti* Culture 8 at 70° F.
(21.1° C.) on three synthetic media.

Media

3% Casein

3% Casein
and
1% Lactose

3% Peptone
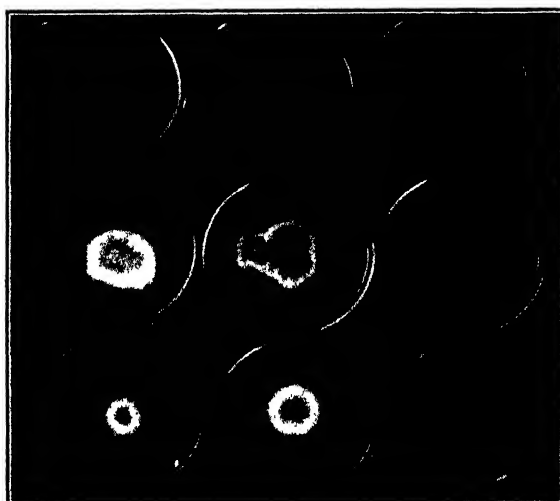
Control air   1 part of air   1 part of air
to 3 parts of N₂   to 3 parts of CO₂

FIG. 5.   The effect of N₂ and CO₂ on the growth of *P. roqueforti* Culture 16 at 70° F.
(21.1° C.) on three synthetic media.

TABLE VI

Growth of strains of P. roqueforti in air and in air and CO_2 (1 to 3) at various
temperatures and in various media

Approximate gas composition: 75% CO_2, 5.2% O_2, 19.8 inert gas.
Temperature of growth: 48° F. (8.9° C.)   70° F. (21.1° C.)
Temperature range: 45° F. to 57° F.   69° F. to 72° F.
Days growth: 17   7

3% Casein

Cultures:	x	y	$\frac{x}{y}$	x	y	$\frac{x}{y}$
16	50.5	No growth		58	25.5	2.28
37	44	" "		57	26.5	2 15
41	29*	" "		50*	18	2 78
8	43.5	Trace		51	22 5	2.27
Average	41.8			54 0	23.7	2.37

3% Casein and 1% Lactose

Cultures:	x	y	$\frac{x}{y}$	x	y	$\frac{x}{y}$
16	56	Trace		67	25	2.68
37	50.5	"		61.5	27	2 28
41	47.5	No growth		53	24	2.21
8	46.5	Trace		55.5	28.5	1.95
Average	50.1			59.3	26.1	2.28

3% Peptone

Cultures:	x	y	$\frac{x}{y}$	x	y	$\frac{x}{y}$
16	29*	No growth		35.5	24	1.48
37	21.5	" "		28.5	No growth	
41	No growth	" "		35.0*	" "	
8	" "	" "		26.5	" "	
Average				31.4		

* Measurement from one colony.

x = Control average diameter of colony in mm. of cultures grown in air.

y = Average diameter of colony in mm. of cultures grown in 1 part of air to 3 parts of N_2.

(1) The control cultures grew poorly on 3 per cent peptone, fairly well in 3 per cent casein, and well in 3 per cent casein plus 1 per cent lactose.

(2) As in all previous tables, 48° F. (8.9° C), 1 part of air to 3 parts CO_2 almost completely inhibited growth.

(3) At 70° F. (21.1° C.) the inhibiting effects of 1 part of air and 3 parts of CO_2 were of the same order of magnitude as previous results. In 3 cases there was no growth in 3 per cent. peptone which at best is a very poor medium. Figs. 4 and 5.

The Effect of N_2 on the Growth of P. roqueforti at Various Temperatures
Tables VII and VIII, Figs. 1, 2, and 3 give the results of the effect of

TABLE VII

Growth of strains of P. roqueforti in air and in air and N_2 (1 to 3) at various temperatures

Approximate gas composition: 5.2% O_2 and 94.8% inert gas.
Media: Malt Agar

Temperature of growth:	48° F. (8.9° C.)			70° F. (21.1° C.)			85° F. (29.6° C.)		
Temperature range:	44° F. to 52° F.			68° F. to 76° F.			83° F. to 86° F.		
Days growth:	10			5			4		
Culture:	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$
1	20.5	27	.76	36	38*	.95	27.5	16	1.72
15	13.0	20	.65	28.5	30	.95	26	18.5	1.41
16	19.0	31	.61	39	40.5	.96	25.5	19.5	1.31
32	18.5	29	.64	36	37	.97	27	23	1.17
33	18	24.5	.74	34.5	35.5	.97	24	18.5	1.30
34	19.5	27.5	.71	37.5	42.5	.88	29	21	1.38
37	18.5	22.5	.82	30.5	30.5	1.00	17	12	1.42
41	19	27.5	.69	39	41	.95	31	23	1.35
43	24.5	30	.82	30	29	1.03	26	19	1.37
3	20.5	25	.82	36	32	1.13	22.5	16.5	1.36
8	16	21.5	.74	36	35	1.03	30	25	1.20
Average	18.8	26	.73	34.8	35.6	.98	26	19.3	1.36

x = Control diameter of colony in mm. of cultures grown in air.
z = Diameter of colony in mm. of cultures grown in 1 part of air to 3 parts of N_2.
* Measurement from one colony.

1 part of air to 3 parts of N_2 (approximately 5.2 per cent O_2 and 94.8 per cent inert gas) on the growth of *P. roqueforti* on malt agar at various temperatures. As with CO_2, the method at 85° F. (29.4° C.) is subject to some question, particularly at the 7-day period, as there was considerable dehydration of the medium since the fit of petri dish lids was not uniform.

Table VII and VIII and Figs. 1, 2, and 3 show:

(1) All controls grew normally.

(2) The depression or acceleration of growth, in an atmosphere of 1 part of air to 3 parts of N_2, appears to be a function of temperature.

(a) At 70° F. (21.1° C.) there was no significant difference between the size of the colonies grown in air and those grown in 1 part of air and 3 parts of N_2. The average values for $\frac{x}{z}$ at 5 days was .98, and for 7 days 1.05. Fig. 1.

(b) At 85° F. (29.4° C.) and 4 days' growth, the control colonies were significantly larger than those grown in 1 part of air and 3 parts of N_2. Fig. 2. The medium was somewhat dehydrated at 7 days.

TABLE VIII

Growth of strains of P. roqueforti in air and in air and N₂ (1 to 3) at various temperatures.
Approximate gas composition: 5.2% O_2 and 94.8% inert gas.
Media: Malt Agar.

Temperature of growth:	48° F. (8.9° C.)			70° F. (21.1° C.)			85° F. (29.6° C.)		
Temperature range:	42° F. to 52° F.			68° F. to 76° F.			83° F. to 86° F.		
Days growth:	14			7			7		
Culture:	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$
1	36.5	42.5	.86	55	58*	.95	45	33.5	1.34
15	26.5	30.5	.87	44	43	1.02	42.5	37	1.15
16	38	51	.75	65.5	65.5	1.00	42.5	41.5	1.02
32	37	48.5	.76	61.5	54.5	1.13	39.5	43	.92
33	34	41	.83	55	54	1.02	35	36.5	.96
34	38	48	.79	62.5	67	.93	41	48	.85
37	32.5	34.5	.94	48.5	44.5	1.09	32.5	33.5	.97
41	39	45.5	.86	64	59	1.09	47.5	43.5	1.09
43	37.5	42	.89	45.5	41.5	1.10	42.5	32	1.33
3	39	39	1.00	55.5	48	1.16	36.5	36	1.01
8	32.5	37.5	.87	58	53	1.09	41.5	46.5	.89
Average	35.5	41.8	.86	55.9	53.5	1.05	40.6	39.2	1.05

x = Control diameter of colony in mm. of cultures grown in air.

z = Diameter of colony in mm. of cultures grown in 1 part of air to 3 parts of N₂.

* Measurement from one colony.

   (c) At 48° F. (8.9° C.), both after 10 and 14 days' growth, respectively, the control colonies were smaller, showing a definite accelerating effect of 1 part of air and 3 parts of N₂. The average values for $\frac{x}{z}$ at 10 and 14 days' growth were .73 and .86, respectively. Thus the accelerating effect was more marked in the younger colonies. There was a considerable difference among some of the strains. Fig. 3.

(3) Variation among strains will be discussed in a later paper.

The Effect of High Concentrations of N₂ on the Growth of P. roqueforti at 48° F. (8.9° C.) and 70° F. (21.1° C.)

Since the previous experiment, Tables VII and VIII, showed no inhibition, but rather an acceleration of the growth of *P. roqueforti* at 48° F. (8.9° C.) and normal growth at 70° F. (21.1° C.), it was considered desirable to repeat the experiment with a few cultures at a higher concentration of N₂. One part of air and 9 parts of N₂ (approximately 2.1 per cent O_2 and 97.9 per cent inert gas) were selected as the atmosphere and the results are given in Table IX, which shows:

   (1) At 70° F. (21.1° C.), both at 4 and 7 days the control grew better than the cultures in 1 part air and 9 parts N₂. This inhibition

<div style="text-align:center">TABLE IX</div>

Growth of strains of P. roqueforti in air and in air and N_2 (1 to 9) at various
temperatures.

Approximate gas composition: 2.1% O_2 and 97.9% inert gas.
Media: Malt Agar.

Temperature of growth:		48° F. (8.9° C.)			80° F. (21.1° C.)	
Temperature range:		45° F. to 56° F.			69° F. to 72° F.	
Days growth:		13			4	
Culture	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$
16	14.33	19	.75	29	23.5	1.23
37	13.33	15	.89	24.5	18.5	1.32
41	17.33	24	.72	33	26.5	1.25
8	17.33	17.5	.99	30.5	23.5	1.30
Average	15.6	18.9	.84	29.3	23.5	1.28
Days growth:		17			7	
Culture	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$
16	32.33	37	.87	64.5	52.5	1.23
37	27	25	1.08	48	35	1.37
41	35.66	39	.91	67	53.5	1.25
8	33.33	30.5	1.10	64	43	1.49
Average	32.1	32.9	.99	60.9	46	1.34

x = Control average diameter of colony in mm. of cultures grown in air.

z = Average diameter of colony in mm. of cultures grown in 1 part of air and 9 parts of N_2.

was relatively slight. The average values for $\frac{x}{z}$ for the 4 cultures at 4 and 7 days were 1.28 and 1.34 respectively.

(2) At 48° F. (8.9° C.) at 13 days the controls had not grown as well as the experimental cultures. At 17 days, growth was about the same, 2 cultures having an $\frac{x}{z}$ value under 1.00, while the others were over 1.00. The average value for $\frac{x}{z}$ for the 4 cultures at 13 and 17 days were .84 and .99 respectively. Fig. 6, taken from a similar series at 18 days' growth for culture 16 at 48° F. (8.9° C.), gives a remarkable example of how well this culture grew in an atmosphere of what must be 2 per cent of O_2 or less, and the remainder largely N_2.

The Effect of N_2 on the Growth of P. roqueforti, Different Synthetic Media Being Used

To establish the general effect of N_2, different media were used. As previously stated, it was to be expected that various media might affect the

different cultures in different ways (10) (11) (12).   However, it was hoped to determine whether or not the general trend was the same.

Table X, Figs. 4 and 5, shows the effect of 1 part of air and 3 parts of

TABLE X

Growth of strains of P. roqueforti in air and in air and N_2 (1 to 3) at various temperatures and in various media

Approximate gas composition: 5.2% O_2 and 94.8% inert gas.

	48° F. (8.9° C.)			70° F. (21.1° C.)		
Temperature of growth:						
Temperature range:	45° F. to 57° F.			68° F. to 72° F.		
Days growth:	17			7		

3% Casein

Culture:	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$
16	50.5	56	.90	58	60.5	.96
37	44	48	.92	57	58	.98
41	29*	No growth		50*	38*	1.32
8	43.5	54*	.81	51	47	1.09
Average	41.8		.88	54	50.9	1 09

5% Casein and 1% Lactose

Culture:	x	z	$\frac{x}{z}$	x	z	$\frac{}{z}$
16	56	63	.89	67	68	.99
37	50.5	50	1.01	61.5	60	1.03
41	47.5	60*	.79	53	51	1.04
8	46.5	51	.91	55.5	49	1.13
Average	50.1	56	.90	59.3	57	1 05

3% Peptone

Culture:	x	z	$\frac{x}{z}$	x	z	$\frac{x}{z}$
16	29*	35.5	.82	35.5	37	.96
37	21.5	23.5	.92	28.5	36	.79
41	No growth	33*		35*	42*	.83
8	No growth	27*		26.5	32.5	.82
Average				31.4	36.9	.85

x = Control average diameter of colony in mm. of cultures grown in air.

z = Average diameter of colony in mm. of cultures grown in 1 part of air to 3 parts of N_2.

* Measurement from one colony.

N_2 at 48° F. (8.9° C.) and 70° F. (21.1° C.) on the 3 synthetic media.

(1) The controls were the same as in Table VI, and as previously stated, the cultures grew poorly on 3 per cent peptone, fairly well on 3 per cent casein, and well on 3 per cent casein plus 1 per cent lactose.

(2) At 70° F. (21.1° C.) for 3 per cent casein and 3 per cent casein plus 1 per cent lactose, there was no significance in the size of

the colonies growing in air and those growing in 1 part of air and 3 parts of N_2. The cultures when grown in 3 per cent peptone showed a distinctly better growth in 1 part of air and 3 parts of N_2. This effect was noticed only with 3 cultures. The $\frac{x}{z}$ values for the 4 cultures in malt agar, Table VIII, and the casein and casein plus lactose were of very similar values, with the exception of culture 41 on casein. With the smaller growth on peptone the results were not comparable.

(3) At 48° F. (8.9° C.) for 3 per cent casein and 3 per cent casein plus 1 per cent lactose, accelerated growth was found in 1 part of air to 3 parts of N_2. The values for $\frac{x}{z}$ are of the order of magnitude previously found with malt agar (Table VIII) when allowance is made for the longer growth period. The cultures grew so badly in peptone that little significance can be attached to the results.

(4) The use of different media, either at 48° F. (8.9° C.) or 70° F. (21.1° C.), did not alter the general trend as found in Tables VII and VIII.

The Capacity of P. roqueforti to Grow in Air Low in Oxygen at 48° F. (8.9° C.) and 70° F. (21.1° C.)

The strains of *P. roqueforti* were grown as in previous experiments, with the difference that gas content was not adjusted daily. In 4 cases the CO_2 produced by growth of the mold was absorbed by placing a porridge dish of concentrated NaOH solution in the bottom part of the desiccator; in the other 2 cases no CO_2 absorbent was used. The same 11 cultures in dulicate, 22 plates in all, were used in each desiccator. Though triplicate colonies of the control checked well, a few of the duplicate colonies in the restricted air supply did not check. This condition could possibly be accounted for by the petri lids not being uniform, which would affect the air above the colony.

Table XI shows:

(1) There was no CO_2 in the desiccator at the end of the period where the NaOH solution was used as absorbent. CO_2 was present in considerable quantity where no absorbent was used.

(2) There was no significant quantity of O_2 left in the desiccators, with the exception of the desiccator in which the cultures were grown at 48° F. (8.9° C.) in the absence of the CO_2 absorbent. However, the 2 other desiccators in which the cultures were grown at 48° F. (8.9° C.) showed a slightly higher O_2 content (.8 per cent) than those at 70° F. (21.1° C).

TABLE XI

The average growth of eleven strains of P. roqueforti in air and in air and nitrogen on malt agar

Initial Atmosphei	Absorbent	Temperature of Incubation	Day's Growth	x	z	$\frac{x}{z}$	Gas Analysis CO_2 %	O_2 %	Inert Gas
1 part of air to 3 parts N_2	NaOH	70° F. (21.1° C.)	8	62.3	49.8	1.26	Nil	.1	99.9
	NaOH	48° F. (8.9° C.)	20	67.9	49.2	1.39	Nil	.3	99.7
1 part of air to 9 parts N_2	NaOH	70° F. (21.1° C.)	8	62.3	37.2	1.69	Nil	Nil	100
" "	NaOH	48° F. (8.9° C.)	20	67.9	47.1	1.45	Nil	.3	99.7
" "	Nil	70° F. (21.1° C.)	8	62.3	36.4	1.73	2.5	Trace	97.5
" "	Nil	48° F. (8.9° C.)	20	67.9	42.1	1.62	3.0	1 4	95.6

x = Control average diameter of colonies in mm. of cultures grown in air.

z = Average diameter of colonies in mm. of cultures grown in an atmosphere diluted with N_2.

Range of temperature for 48° F. (8.9° C.) incubator 46° F. to 68° F.

Note: The 68° F. is due to refrigeration being off for 30 hours.

Range of temperature for 70° F. (21.1° C.) incubator 67° F. to 72° F.

(3) The average growths must be discussed in pairs; *i.e.*, lots with the same initial atmosphere but varying in temperature of growth.

    (a) In an initial atmosphere of 1 part of air to 3 parts of N_2, the average value for z at both temperatures was practically the same. Thus the mold colonies at 48° F. (8.9° C.) and 70° F. (21.1° C.) stopped growth at the same size in the restricted air supply, while the controls grew on, reaching the greater size at 48° F. (8.9° C.).

    (b) With an initial atmosphere of 1 part of air to 9 parts of N_2 held over NaOH, the average z values showed better growth at the lower temperature. It is probable that the colonies at the lower temperature got more O_2 by absorption and that the type of growth was more spreading.

    (c) With an initial atmosphere of 1 part of air to 9 parts of N_2, with no CO_2 absorption, the average z values showed slightly better growth at the lower temperature. However, had all the O_2 been used up at the lower temperature, the z values would probably have been similar to the last pair.

(4) Discussing the second and third pair at the same initial atmosphere, with and without a CO_2 absorbent, it was found the removal

of CO_2 increased growth, which increase was marked at the lower temperature.

DISCUSSION

It must be pointed out that in no cases do these data conflict with the previous data cited, but they do conflict with the statements explaining such data (24) (35). Had Thom and Currie (35) used N_2 as well as CO_2 to dilute the O_2 of the air in their Novy jars they would have found very different results with the former gas than they did with the latter. Also, had they used the ripening temperature of Roquefort cheese (48° F.) (8.9° C.) for incubating their cultures, they would have been more impressed with the inhibiting effect of CO_2. The data herein reported show clearly that the gas requirements of *P. roqueforti* are functions of both concentration and temperature and vary with different gases. The inhibiting effect of CO_2 varies greatly with temperature. The O_2 requirements appear, also, to be a function of temperature. Whether or not the variation between strains is associated with maximum, minimum and optimum temperatures of their growth in air, is yet to be determined and will be taken up more fully in a later paper. Furthermore, the work points to maximum, minimum and optimum temperatures of growth as being variable with gas supply. In this respect it must be pointed out that the findings of Thom and Currie (35) regarding the restriction of growth by CO_2 on a large number of Penicillia might produce quite different results at another temperature. Let it be assumed for the moment that the findings in this study apply to all Penicillia. Then the organisms used by Thom and Currie (35), which were grown in high concentrations of CO_2 at room temperature, would either be at, above or below their optimum temperature of growth in air. Thus an organism with a high optimum temperature of growth would naturally be more restricted by CO_2 at room temperature than one which has its optimum at the room temperature used.

From the standpoint of blue veined cheese making and ripening the results are of fundamental importance. The presence of CO_2 rather than the absence of O_2 is the limiting factor in the growth of *P. roqueforti* in the cheese, particularly as the ripening temperature of these cheeses is between 40° F. (4.4° C.) and 50° F. (10° C.). A cheese is punched, pricked or skewered, not to admit O_2 but rather to allow CO_2 to escape. The production of CO_2 by lactic bacteria is undoubtedly carried on in the cheese (37). The extent of CO_2 production will largely depend on the type of organisms present (2) (18) (19) (20). In the selection of a starter for cheese making it is possible to choose one of the type A starters (2) which will produce large quantities of CO_2, having an inhibiting effect on the growth of *P. roqueforti*. On the other hand, selection of a starter of the type B starter (2) will result in the production of much less CO_2, a condition favorable
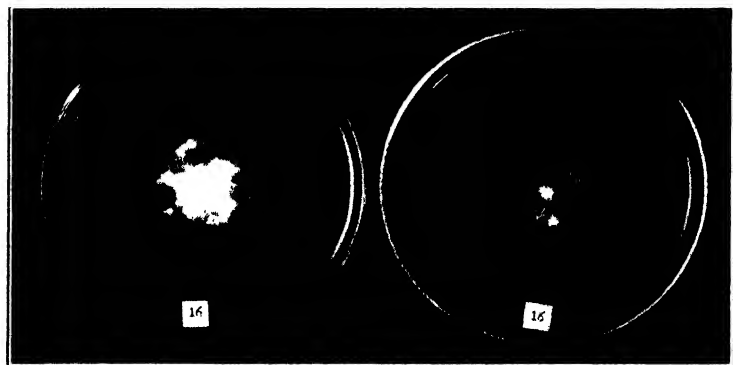
FIG. 6

1 part of air
to   Control air
9 parts of N₂

The effect of N₂ on the growth of *P. roqueforti* Culture 16 at 48° F. (8.9° C.)

for the growth of *P. roqueforti.* The latter starter also would allow for the use of the more desirable lower cheese ripening temperatures. With more attention to the selection of starters by their CO_2 production, continuous success with blue veined cheeses, Roquefort, Gorgonzola, Stilton, and Wensleydale, will probably be attained.

It is to be regretted that in the experiments presented in this paper as well as in others cited, (4) (15) (24) (32) too close attention to the practical application results in limitation of fundamentals. If this work could be continued from the extreme maximum temperature of growth in air to the extreme minimum temperature of growth in air, with variations in N_2, O_2 and CO_2 content, curves could be drawn for $\frac{x}{y}$ and $\frac{x}{z}$ from zero to 100 per cent concentrations.

CONCLUSION

(1) CO_2 inhibits the growth of several strains of *P. roqueforti* in several different media. The degree of inhibition is uniform with the medium but varies with concentration of CO_2 and temperature. With 75 per cent CO_2 the effects are:

  (a) At 85° F. (29.4° C.) the inhibition is very considerable, such that little more than germination takes place.

  (b) At 70° F. (21.1° C.) the inhibition is only partial, the colonies being about half the size of those grown in air.

  (c) At 48° F. (8.9° C.) the inhibition is almost total.

(2) The reduction of the O_2 by added N_2 affects the growth of several strains of *P. roqueforti* in several different media.

(a) At 85° F. (29.4° C.) in an atmosphere of 1 part of air to 3 parts of N_2 the inhibition is slight.

(b) At 70° F. (21.1° C.) the cultures grow in 1 part of air to 3 parts of N_2 as well as in air.

(c) At 48° F. (8.9° C.) the growth in 1 part of air to 3 parts of N_2 is considerably accelerated over that in air.   Even in 1 part of air to 9 parts of N_2 there is no inhibition.

(3) Where CO_2 is removed by NaOH the strains of *P. roqueforti* growing in low O_2 pressure, removed all but a trace of O_2, at both 70° F. (21.1° C.) and 48° F. (8.9° C.).

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THE EFFECT OF FAT CONTENT ON OXIDIZED FLAVOR IN MILK AND CREAM

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Practical experience and observation has shown that milk plants which produce two grades of pasteurized milk generally encounter much more difficulty with oxidized flavor in the high-fat premium-quality grade than in the standard grade. Roland, Sorensen, and Whitaker (1) studied oxidized flavor in commercial pasteurized milk and concluded that both the bacteriological quality of the milk and its fat content were related to the flavor defect. Tracy and Ruehe (2) reported the results of adding a small quantity of a lactic acid solution of copper oxide to four milk products ranging in fat content from skim milk to 4.9%. In the series the oxidized flavor became more apparent as the fat content increased. They found that skim milk did not develop oxidized flavor but developed metallic flavor.

In order to study systematically the effect of fat content on the sensitivity of milk and cream to copper-induced oxidized flavor, a series of laboratory experiments were undertaken. Samples of milk and its products of various fat contents obtained by separation and recombination were tested for sensitivity by pasteurizing them in presence of definite areas of metallic copper surfaces.

PROCEDURE

A commercial grade of 17 gauge copper wire was used as a source of metallic copper. Pieces varying in length from 7.5 inches to 60 inches were cleaned by abrasion with powdered pumice stone on a piece of moistened blotting paper and then rinsed in cold water. Inasmuch as freshly cleaned copper was found to discolor in a relatively short time in the laboratory atmosphere, care was taken to prepare sample pieces immediately before use. The wire was coiled, using paper to handle it, on a glass rod of approximately ¼ inch diameter. In this arrangement 30 inches of wire formed a coil about 2 inches long. Longer coils were bent horseshoe fashion so that all would fit into wide mouthed 250 cc. Erlenmeyer flasks. Cold (40°F.) milk or cream in 100 cc. portions was introduced into the flasks containing the coils and thin sheets of aluminum foil were placed over the mouths of the flasks and crumpled down tightly over the lips to prevent evaporation and uncontrolled aeration. Heating to 143° F. required 5 to 6 minutes and was effected by placing the flasks into a water bath at 160°F. and agitating the flasks with a circular motion of the hand. They were then transferred to another bath and held at 143°F. for 30 minutes. After

holding for 15 minutes the milks were agitated gently and after 30 minutes the flasks were transferred to an ice-water bath where they were cooled to 50°F. by agitating for 15 minutes. The copper was removed and the milks were poured into gill bottles and closed with a regular milk bottle cap under which was inserted a square piece of thin aluminum foil to prevent the milk from ever being in contact with the paper cap. The samples thus prepared were stored for 24 and 48 hours at 40°F. and tasted after warming to 80° or 90°F. The samples were always tasted by two judges whose opinions were in good agreement. The following system of scoring was used:

Character of Flavor	Score
No off flavor	4.0
Slight off flavor; questionable	3.5
Slight oxidized flavor	3.0
Definite oxidized flavor	2.0
Strong oxidized flavor	1.0
Very strong oxidized flavor	0.0

A given sample was rated by adding the scores of each independent tasting at the two storage periods, and dividing by 4. The scores of the oxidized flavor samples were usually about 1 point lower at 48 hours than at 24 hours. Although this system of grading is not applicable to all flavor defects, it served very well since a more or less "pure" type of oxidized flavor always developed; namely, that induced by metallic copper under comparable conditions. The fat content was determined by the Babcock method.

EXPERIMENTS

Mixed raw certified milk (July 1935) was separated at 95°F. to cream of 32% fat. The cream and skim milk were recombined to form a series of products ranging in fat content from 0.04% (skim) to 8.6%. To 100 cc. portions of each product were added pieces of coiled copper wires of lengths

TABLE I

First experiment: Effect of fat content on the sensitivity of standardized certified milk to copper-induced oxidized flavor

SQ. INCHES COPPER PER 100 CC.	FLAVOR SCORE						
	0.04% fat	0.9% fat	2.9% fat	4.9% fat	5.1% fat*	6.8% fat	8.6% fat
0.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
1.4	4.0	4.0	3.8	3.9	4.0	3.6	3.8
2.7	4.0	4.0	3.6	3.8	2.5	3.3	3.0
5.4	3.8	3.6	3.1	2.8	1.5	2.3	0.8
8.1	3.4	3.3	2.3	1.3	0.8	0.8	0.0

* This sample was the unstandardized stock milk.

corresponding to areas of 1.4, 2.7, 5.4, and 8.1 square inches. The milks containing the copper were then pasteurized and handled according to the

TABLE II

Second experiment: Effect of fat content on the sensitivity to copper-induced oxidized flavor of standardized milk and cream from country cooling station mixed raw milk

SQ. INCHES COPPER PER 100 CC.	FLAVOR SCORE					
	0.025% fat	4.3% fat*	5.0% fat	12.0% fat	20.0% fat	40.0% fat
0.0	4.0	3.9	3.9	3.8	4.0	4.0
0.9	3.8	3.6	4.0	4.0	3.8	4.0
5.4	4.0	1.3	2.0	1.8	0.8	0.3

* This sample was the unstandardized stock milk.

standard procedure described above. The flavor scores of the samples are shown in Table I. The relation between fat content and copper surface required for the induction of oxidized flavor of 3.0 score (estimated by interpolation) is shown graphically in Figure 1. It appears that changes in fat content or the variations in the composition of milk which accompany increase in fat content, significantly affect the sensitivity of the milk. It is to be noted that the stock milk (control) values do not fit into the curve of the standardized products. Apparently separation produced a marked change in the products. In the skim milk of this experiment (0.04% fat) a slight off flavor developed when it was pasteurized with relatively large amounts of copper surface.

A second experiment was made in which mixed raw milk procured from a country cooling station in August, 1935, was separated at 95°F. and products ranging in fat content from 0.025% to 40.0% were prepared. Portions of 100 cc. were pasteurized according to standard procedure with 0.9 and 5.4 square inches of copper surface. The resulting effect on flavor is shown in Table II. The scoring of the high-fat samples on a comparative basis with milk was difficult; but it appears that the sensitivity continues to increase with increase in fat content or the changes accompanying variation in fat content.

A third experiment was made in which mixed raw milk procured from a country cooling station in August, 1935, was separated at 95°F. and

TABLE III

Third experiment: Effect of fat content on the sensitivity to copper-induced oxidized flavor of standardized milk and cream from country cooling station mixed raw milk

SQ. INCHES COPPER PER 100 CC.	FLAVOR SCORE				
	0.03% fat	3.7% fat	18.0% fat	26.5% fat	33.0% fat
0.0	3.8	..	4.0	4.0	4.0
2.7	3.8	3.5	3.5	3.2	2.7
5.4	3.3	2.0	0.7	1.0	0.7

TABLE IV

*Fourth experiment: Effect of fat content on the sensitivity of standardized certified milk
and cream to copper-induced oxidized flavor*

SAMPLE NO.	FAT CONTENT %	FLAVOR SCORE							
		Square inches copper per 100 cc. of product							
		0.0	1.4	2.7	3.1	5.4	6.8	8.1	10.8
13	0.04	4.0	3.8	3.9	3.9	3.7	3.8	3.7	3.5
12	1.1	4.0	3.9	3.9	3.9	3.8	3.7	3.4	3.3
11	1.8	4.0	3.9	3.8	3.9	3.6	3.6	3.6	3.3
10	2.8	4.0	4.0	3.8	3.8	3.4	3.4	3.3	2.5
1*	3.3	4.0	3.6	3.3	2.6	2.2	2.6	1.7	1.0
2**	3.3	4.0	3.8	3.5	3.3	2.6	3.0	2.2	2.0
9	3.6	4.0	3.9	3.9	3.5	3.3	3.1	3.2	3.1
8	5.4	3.9	3.8	3.5	3.6	3.7	3.2	2.7	1.7
7	7.3	4.0	4.0	3.8	3.3	2.7	2.7	2.3	1.5
6	8.4	4.0	3.8	3.8	3.4	2.7	3.3	3.1	1.2
5	20.0	4.0	4.0	4.0	3.6	3.3	2.3	2.0	1.5
4	26.3	4.0	3.9	3.8	3.3	3.0	2.5	2.3	1.3
3	37.5	3.8	3.9	3.8	3.4	3.5	2.2	1.7	1.5

* This sample was the unstandardized stock milk held cold.
** This sample was the unstandardized stock milk held at 95° F. for 30 minutes.

TABLE V

Fourth experiment: Chemical and bacteriological data on products used

SAMPLE NO.	% FAT	RAW PRODUCTS		PAST. PRODUCTS		% Lecithin
				No copper	10.8 sq. in. copper	
		Microscopic count	Colony count	Colony count	Colony count	
13	0.04	< 14,000	5,600	20	10	0.011
12	1.10	< 14,000	5,800	< 10	10	
11	1.80	14,000	7,750	20	30	0.018
10	2.75	< 14,000	5,900	< 10	10	0.017
1	3.30*	56,000	4,050	20	< 10	0.025
2	3.30**	< 14,000	3,200	< 10	20	
9	3.55	< 14,000	6,600	< 10	< 10	0.020
8	5.35	< 14,000	6,500	< 10	20	
7	7.25	< 14,000	5,050	30	30	0.037
6	8.35	< 14,000	7,900	20	30	
5	20.00	28,000	6,850	< 10	30	0.048
4	26.25	< 14,000	4,400	< 10	< 10	
3	37.50	14,000	2,650	10	< 10	0.163

* Sample No. 1 was cold raw milk.
** Sample No. 2 was raw milk held at 95° F. for 30 minutes.

products ranging in fat content from 0.03% to 33.0% were prepared. Portions of 100 cc. were pasteurized according to standard procedure with 2.7 and 5.4 square inches of copper surface. The resulting effect on the flavor
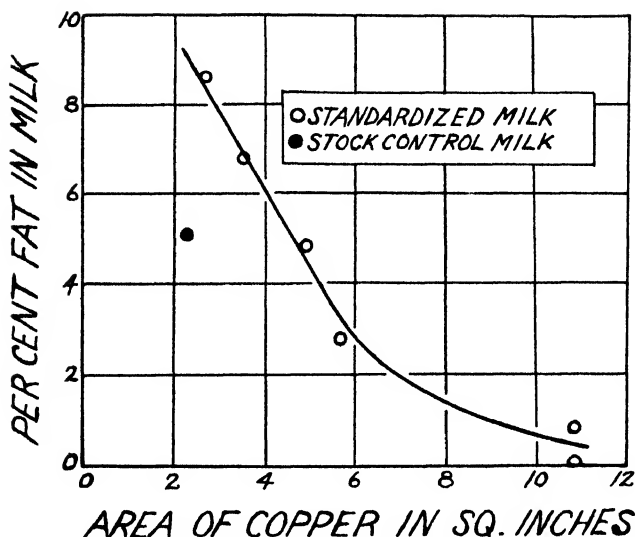
FIG. 1. AREA OF COPPER REQUIRED FOR THE PRODUCTION OF OXIDIZED FLAVOR IN STANDARDIZED MILK (100 CC. SAMPLES).

of the products is shown in Table III. The unstandardized stock milk sample in this experiment was lost.

A fourth experiment was made in October, 1936, in which fresh raw mixed (mostly Holstein) certified milk was separated at 95° F. and a series of products ranging in fat content from 0.04% to 37.5% were prepared from the cream and skim milk. Special care was taken to carry out the whole operation aseptically. All equipment was sterilized with hot water and steam and the skim milk and cream were run into ice packed containers and kept below 50°F. Samples of the original cold milk, the same milk warmed to 95°F. and held until separation was complete, and samples of the standardized products taken the following day when they were opened for laboratory tests, were subjected to bacteriological and chemical examination. Portions of 100 cc. were pasteurized according to standard procedure with 1.4, 2.7, 3.1, 5.4, 6.8, 8.1 and 10.8 square inches of copper surface. Samples of milk pasteurized with 10.8 square inches copper per 100 cc. and of the control pasteurized with no copper were also examined bacteriologically. The raw stock samples were tested for fat content and the lecithin content of five of them was determined by the method of Weise et al. (3).

The flavor scores of the samples are shown in Table IV. Chemical and bacteriological data on the samples are summarized in Table V. From the results it appears that the recombined milk was considerably less sensitive to oxidized flavor than the control unseparated milk and that a definite relation again was shown between fat content and sensitivity. It appears also

that separation lowered the phospho-lipoid (lecithin) content of the milk as is shown by comparing sample No. 1 and No. 9 in Table V. Assuming a direct relationship between the fat content of these samples and the phospho-lipoid content then a standardized milk of the same phospho-lipoid content as the control milk would have a higher fat content than the control milk. This suggests that the phospho-lipoid content of the standardized milks may be related to their sensitivity to oxidized flavor and supports the work of Thurston, Brown, and Dustman (4) who concluded that the lecithin content was related to the sensitivity of milk products to oxidized flavor.

The bacteriological examination shows that there was no appreciable growth of micro-organisms during the experiment and minimizes the possibility of decreased sensitivity from the growth of micro-organisms.

CONCLUSIONS

A method was developed for determining the relative sensitivity of milk and cream to oxidized flavor induced by pasteurizing them in the presence of metallic copper.

The sensitivity of standardized milk and cream to copper-induced oxidized flavor appears to be definitely related to the composition of the products as determined by the fat content. A variation of about 1% fat in the range of whole milk was detected by a significant change in the flavor score. Skim milk exposed to large areas of copper surface developed a slight metallic flavor but never an oxidized flavor.

The mechanical separation of milk produced a marked decrease in its sensitivity to copper-induced oxidized flavor as evidenced by tests on milk made by recombining cream and skim milk. Removal of lecithin or related substances by the separator or changes in their distribution between fat and aqueous phase may be responsible for the decreased sensitivity. This suggests a means for reducing the sensitiveness of commercial milk to oxidized flavor.

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THE CHEMICAL ANALYSIS OF BUTTER FOR MOISTURE, SALT, CURD AND FAT

At present there are two generally accepted methods for butter analysis. The older one, advocated by the Association of Official Agricultural Chemists (A. O. A. C.), and used by the Federal Government and States Chemists, has however not been favored by the average creamery operator. A later method suggested by Kohman (Kohman, Edward S., Journal of Ind. and Eng. Chem., Vol. XI, No. 1, p. 36, 1919) because of its greater simplicity, has attained much wider usage in creameries of the country. Changes have been suggested so that now the method is frequently referred to as the "Modified Kohman" method. There is a great lack of agreement among the users of the latter test, both as to equipment and procedure. Because of this, and also because it is so universally used by the industry, the American Dairy Science Association subcommittee on the chemical analysis of butter felt that it should be given primary consideration. There should be available to the creameries and smaller commercial laboratories of the country standard instructions, so that uniformity in results may be expected. This report supersedes a previous report (JOUR. DAIRY SCI., Vol. 13, p. 380, 1930) of this committee.

In the discussion of equipment as well as methods, alternate suggestions are included, so that the laboratory with sufficient funds or with trained personnel may select those which appear most practical. Those alternate suggestions which produce equally satisfactory results will be found in footnotes.

EQUIPMENT AND SUPPLIES

(A) A spatula with a stiff 4″ stainless steel blade for taking and mixing samples.

For larger laboratories:

A mechanical mixer as suggested by D. H. Nelson (JR. OF DAIRY SCIENCE, Vol. XVIII, No. 10, p. 667). It consists of an electric motor having a speed of 1725 r.p.m. and a rating of ¼ horsepower. A chuck similar to that of an electric drill is mounted directly on the shaft. A solid center bit which has had the tip or worm and the two cutters removed is placed in the chuck. When the motor turns the bit is turned in the opposite direction from that when it is used for boring. This motion throws the butter into the bottom of the sample jar which is slipped over the bit. The bit should be preferably of ¾ inch size, and have a solid shaft through the ribs in order to facilitate cleaning. Finally a piece of tin shaped in a half circle is placed on the bench over the bit in order to catch any pieces of butter that may fly off the

bit when the sample jar is removed. Sample jars should have straight sides and flat bottoms. Their capacity should be 190 per cent of the volume of butter. Temperatures of 53° to 77° F. are satisfactory.

Wilster (Oregon Agricultural Expt. Sta. Bul. 338) designed a stirrer with a vertical specially constructed agitator. The jar of butter is placed on a platform and held in place by a spring while a 1/30 h.p. motor with a variable speed of from 0 to 1725 r.p.m. drives the agitator. The features of the agitator should be such that all parts of the butter are stirred.

(B) A suitable sample jar of non-absorbent material, preferably with a straight side and a tight fitting non-absorbent closure such as a metal screw cap or glass top with a rubber gasket. Four ounce aluminum screw cap jars permit writing identification numbers on the cap.

(C) A polished aluminum beaker having a capacity of 150 ml. and which is at least 3″ tall.

(D) Crucible tongs sufficiently large to handle the aluminum beakers.

(E) A special type balance for the determination of moisture and fat. The balance should have a sensibility reciprocal of not over 15 milligrams. The beams should be so graduated that percentages may be read to the nearest 0.1 per cent if a 10 gram sample of butter is used.

Wilster (Oregon Agr. Expt. Sta. Bul. 338) suggests a modified balance which may be obtained from the Torsion Balance Company, 92 Reade St., New York, N. Y. This balance differs from those usually found in dairy plants, in that it carries an auxiliary 10 gram beam, graduated from 0 to 100 in 10 per cent divisions. Only one 10 gram weight is necessary if this balance is used, provided the cups are of very nearly the same weight.

(F) A 10 gram weight, if the modified balance is used, or a 10 gram and a one gram, or a nine gram weight. For larger laboratories a block of weights sensitive to 0.01 grams is suggested.

(G) A tripod with asbestos mat and a laboratory alcohol lamp or gas flame. Instead of the alcohol lamp or gas flame an electric hot plate with a three heat switch or a high pressure steam oven with a temperature not over 300° F. may be used satisfactorily. For larger laboratories a vacuum oven similar to that used with the Mojonnier tester may be advantageous.

(H) A cooling plate, such as an old flat iron, may be used provided it is located in a dry room and if a glass cover is used on the beaker. A humidor may be converted into a home-made desiccator by placing a drying chemical, such as calcium chloride, in the bottom with a metal platform above, for supporting the cups. The cover may be made airtight by spreading vaseline around the edges. For faster work a Mojonnier type cooling dessicator or a warming and cooling chamber

as proposed by Wilster (Oregon Agr. Expt. Sta. Bul. 338) may be used. The latter consists of a small closed tank which has several compartments, each closed at the bottom and with a diameter slightly greater than the aluminum cups used. Additional compartments may be provided for sample jars. The water surrounding these compartments is heated by steam for warming the samples or it may be used for cooling by passing cold water through the tank. Since the tank is closed, any danger of water splashing into the samples is avoided.

(I) A[1] suitable fat solvent such as petroleum ether. In order to be satisfactory a solvent should have a low specific gravity, leave no residue upon evaporation, should volatilize rapidly, and be moisture free, since otherwise a small quantity of salt will go into solution. The U. S. Pharmacopoeia requirements for petroleum ether are: specific gravity 0.634 to 0 66 at 77° F.; U S P. distillation between 95° to 176° F.

(J) A roll of tissue for wiping triers or spatulae.

(K) A rubber tipped glass stirring rod.

(L) Silver nitrate solution prepared by dissolving 29.064 grams of pure silver nitrate crystals in distilled water and making up to one liter.

(M) A small supply of a 5 per cent potassium chromate solution in distilled water.

(N) A 50 ml. burette with stand or a Nafis automatic type flask and burette.

(O) A 250 ml. volumetric flask.

(P) A 25 ml. pipette.

(Q) A white cup.

(R) A butter trier (not always necessary).

<div align="center">PROCEDURE FOR ANALYZING BUTTER</div>

(A) Sampling.

    1.[2] From the churn.

        Select a clean thoroughly dry sample jar. With a ladle remove the top layer of butter from a small area, and by use of the spatula, immediately remove 10 to 15 grams of butter from the exposed area. Ten to twelve such samples should be taken from nearly equally spaced areas along the full length of the churning. Care should be exercised that moisture from the walls of the churn does not drop into the sample jar.

[1] High test gasoline and some special low priced cleaning solvents may be used satisfactorily. Solvents with a specific gravity up to .73 and distillation between 300° and 400° F. have been used successfully.

[2] If so desired, at least five trierfuls of butter may be taken at right angles to the roll of butter. All butter excepting that which adheres to the back of the trier should be transferred to the sample jar. The trier should be wiped before taking each plug.

2. Sampling a single large box or tub.

A single trierful should be taken by boring diagonally from the top to the bottom. About an inch of butter from each end of the trier should be eliminated. At least two packages from a churning should be sampled, or three if there are more than 20 packages in the churning. If but one package were sampled three trierfuls rather than one as suggested above are to be taken. One of these should be removed from the center and the other two, opposite one another, about half-way between the center and the outside rim.

If the butter has been properly worked, it may be transferred from the trier to the sample jar by use of a spatula. Moisture adhering to the back of the trier is negligible unless the butter is improperly worked, in which event the sample would not be representative and results should be regarded as approximate only.

3.[3] Sampling a one pound print.

The print should be quartered lengthwise and then all quarters cut transversely in half. Two diagonally opposite eighths are used for the sample.

(B) Preparing the Sample for Analysis.

Samples for analysis should be softened by placing in a water bath at a temperature of 90° to 95° F. (depending upon the consistency of the butter). The sample should be the same color as the hard butter and be only soft enough so that it will not retain its shape when raised to a point by the flat side of a spatula. Particular care should be taken to keep the sample jar tightly sealed at all times except when the butter is being stirred or when the sample is weighed. The method selected for mixing depends upon the number of samples to be tested and the size of the laboratory. The following methods are suggested:

1. A four inch stiff bladed spatula. Extreme care is necessary to see that the mixing is complete and that all butter is removed from the corners of the container. A consistency like that of mayonnaise is desirable. The color of the mixed sample should be uniform throughout.

2. Motor driven mixers as proposed by Nelson (JOUR. OF DAIRY SCIENCE, Vol. XVIII, No. 10, p. 667) or Wilster (Oregon Agr. Expt. Sta. Bul. 338). The operator should assure himself that mixing is complete so that the sample is consistent throughout (at least three minutes for the Nelson mixer).

[3] Another acceptable method for well worked butter would be to cut the print in two halves and then a ½″ to ⅜″ slab should be removed from one of the freshly cut surfaces and transferred to the sample jar.

(C)[4] Weighing the Prepared Sample.

When more than one sample is to be tested, the scale first should be balanced. This is done so that the operator may check it before weighing back his cups after the moisture evaporation or fat removal. Thus he is assured of satisfactory weighings. If a Torsion balance is used, the riders on the graduated beams should be at the extreme left. If the large tare rider is on an ungraduated beam it is usually placed at the extreme right of the beam. The beaker should be weighed by placing it on the right-hand pan and its weight recorded. The beaker used should be perfectly clean and dry and of constant weight. It should be weighed cold. Under ordinary conditions exactly 10 grams of the prepared sample of butter should be weighed into the beaker as quickly as possible, and should be placed on the bottom of the dish if possible.

(D) Evaporation of the Moisture.

The beaker is transferred to an electric hot plate, an alcohol lamp, gas flame or pressure oven to evaporate the moisture. If an open flame is used it is advisable to use an asbestos screen or pad to prevent the deposit of carbon on the beaker. The evaporating temperature should not exceed 300° F. since higher temperatures tend to produce spattering. The sample should be agitated frequently so that the formation of a casein scum is prevented. Evaporation should be continued until the color is a golden brown or until no fresh foam bubbles are formed.

(E) Cooling the Sample.

The dried sample should be weighed at the same temperature as the original weighing. Cooling should be so carried out that no moisture is reabsorbed by the sample. Neither should free moisture cling to the beaker and, therefore, cooling the sample by holding the beaker in cold water is inadvisable except by a highly trained operator and only when highly polished beakers are used.

The most satisfactory methods of cooling are those suggested under the list of cooling equipment.

(F) Determining the Moisture Content.

The perfectly dry, cool beaker is placed on the right hand pan of the previously balanced scale and the tare weights adjusted. If a 10

[4] If larger laboratories prefer, the following method may be used: Approximately ten grams of the prepared sample of butter are placed quickly in the cup or beaker. A watch glass or metal disk should be placed on the beaker as quickly as the butter is delivered into it, so that there will be no evaporation while the exact weight is obtained. When this procedure is followed, a block of weights sensitive to 0.01 gram is necessary. To obtain the amount of butter, the weight of the empty beaker is subtracted from the combined weight of the beaker and butter. (JOURNAL OF DAIRY SCIENCE, Vol. XVI, p. 303.)

gram sample of butter was used, the per cent moisture may be read directly off the graduated beams on the Torsion type scale.

(G) Determining the Fat Content.

1. After the per cent moisture has been determined the sample should be warmed and approximately 100 ml. of solvent added. The mixture should be stirred with a rubber tipped glass or steel rod. The sample should be allowed to stand not less than four minutes, after which the solvent should be poured off slowly until only a few drops remain. Pouring off the solvent without loss of the settlings may be facilitated by setting the beaker at an angle with the pouring lip down during the settling period. The process should be repeated using not over 100 ml. solvent. After the second decantation, the remaining solvent should be evaporated by low heat on the electric hot plate, or by setting on a steam pipe. High temperatures with some solvents result in spattering. When properly dried no solvent odor should be noticeable and the salt and curd remaining in the beaker should be powdery.

2.[5] Weighing the Sample.

After the solvent has been evaporated completely the beaker is cooled, as for the moisture determination. It then is placed on the right-hand pan of the scale, and the amount of residue (curd and salt) remaining in the beaker is determined. A one gram weight may be substituted for the ten gram weight used for weighing the sample, or a nine gram weight may be placed with the cup on the right hand pan, and the ten gram weight retained on the left hand pan. The sliding weights on the graduated beams are moved so the scale is balanced. The readings on the graduated beams (expressed in per cent) when subtracted from ten gives the per cent salt and curd. The per cent of salt and curd plus the per cent moisture, subtracted from one hundred then gives the per cent fat.

By using the scale proposed by Wilster the readings will be simplified.

(H)[6] Determining the Salt Content of Butter.

1. The salt test may be made directly on the residue remaining from the fat test. If a ten gram sample of butter was used the resi-

[5] Where other than a ten gram sample of butter is used the per cent of fat is calculated as follows:

$$\frac{\text{Weight before extraction—Weight after extraction}}{\text{Weight of butter used}} \times 100 = \text{per cent fat.}$$

[6] If so desired, the entire 250 ml. sample may be titrated. Five or six drops of potassium chromate solution are used. One ml. of the silver nitrate solution is equivalent to one-tenth per cent salt.

Slightly greater accuracy may also be attained by use of a silver nitrate solution of one-half the concentration proposed. In that case two ml. of silver nitrate solution are equivalent to one per cent salt.

due is rinsed from the beaker and made up exactly to 250 ml. with warm chlorine free water. Twenty-five ml. of the solution are placed in a white cup and two or three drops of potassium chromate solution added. Silver nitrate solution then is added until a flesh or light orange color develops. One ml. of the silver nitrate solution is equivalent to one per cent salt.

2. If the salt test is made directly upon a ten gram sample of butter, enough warm chlorine free water should be added so that the bottom of the fat column will be at the 250 ml. mark on the flask. Twenty-five ml. of the fat free solution is then used for titration as described above.

(I) Determining the Curd Content of Butter.

The curd content is determined by difference, which means that the per cent salt may be subtracted from the combined salt and curd percentage if the Modified Kohman test has been used.

(J) The accuracy of the method of analysis described does not permit results beyond the nearest one-tenth per cent.

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SUBCOMMITTEE ON BUTTER ANALYSIS

D. H. NELSON
G. H. WILSTER
S. T. COULTER
M. E. PARKER
L. C. THOMSEN, *Chairman*

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NUTRITIVE VALUE OF CHOCOLATE FLAVORED MILK

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INTRODUCTION

The fact that some dairymen are advertising chocolate milk as a real health food for children and for convalescents and that schools rank second as chocolate milk sales outlets (1) brings up the old question of the nutritive value of cocoa and the question of whether cocoa should be included in children's dietaries. Most of the reported experimental work on this problem is controversial. The extensive use of cocoa has been criticized because it contains theobromine and, to a lesser extent, caffeine. However, pathologists generally agree that the objection to the use of chocolate milk because of the theobromine content is not fundamental. Another objection raised to chocolate milk is its sugar content which is considerably higher than that of whole milk. Although most investigators concede that the tannic acid content in cocoa is too small to be of any significance, they disregard the high content (2.35 to 5.9 per cent) of cacao red which resembles tannin in many of its properties.

Cocoa and chocolate are made from the nibs of cacao-beans. The cacao-bean is the seed of the cacao-tree, and its component parts are the shell, nib and germ. Chocolate is the solid or plastic mass obtained by grinding the roasted or dried nibs; while cocoa, or powdered cocoa, is chocolate deprived of a portion of its fat and pulverized. There are U. S. Federal definitions and standards for cacao products (2). Space does not permit to give the standards in detail; however, it should be mentioned that they specify in general the minimum fat content and the maximum ash and crude fiber content of cacao products. The composition of commercial cocoas varies considerably according to the composition f the cacao-bean used, the extent to which the fat has been removed, and the method of manufacture. The following figures taken from Whymper's "Cocoa and Chocolate" (3) give the main components of commercial cocoa powder.

Cocoa is more likely to be used in milk for its flavor than for its food value. As used in making ordinary chocolate milk, the food value of cocoa is negligible. However, there is a possibility that the small amount of cocoa added to milk may have a marked effect on the digestibility of the milk solids. Whymper (3) states that tannin decreases the solubility of milk solids. Neumann (4), (5) studied the digestibility of cocoa, using himself

	PER CENT		
Moisture	2.25	to	5
Ash, American Process	3	"	5
Dutch Process	5	"	11
Fat	22	"	35
Extractive soluble in water	13.5	"	18.5
Theobromine	0.7	"	2.7
Starch	2	"	11
Fiber	2.5	"	6.5
Proteins	10	"	17
Oxalic acid	0.4	"	0.65
Sucrose	Trace		
Cacao red	2.35	"	5.9

as a subject for 86 days, and reports that the addition of cocoa to other articles of food seems to reduce the total amount of nitrogen absorbed. He also found that the amount of fat present in the cocoa affects the absorption of nitrogen, a reduction in fat lowering the assimilation of nitrogen.

OBJECT OF STUDY

In view of these reports, this study was undertaken with the hope of demonstrating by animal feeding experiments whether the addition of cocoa to milk changes the nutritive value of the milk. Also, it was hoped to secure some data which might aid health officials in setting up standards for chocolate milk. The authors are aware of only one instance where such standards have been set up. The Baltimore City Health Department (6) requires a minimum fat content of 2.5 per cent and the permissible maximum cocoa and added sugar are 5 and 6 per cents, respectively. Because of the lack of information on the nutritive value of chocolate milk, it was necessary to depend upon trade practice and consumers' preference when formulating these standards.

EXPERIMENTAL

The general plan was to feed one group of albino rats whole milk and other groups whole milk to which various percentages of cocoa had been added. Both control and the chocolate milk diets were supplemented with cane sugar and with iron, copper and manganese, according to the procedure reported by Elvehjem *et al.* (7). These investigators have made studies which suggest that the rate of growth of male rats on mineralized milk is an excellent measure of changes in the nutritive value of that milk.

The cocoa used throughout this experiment is a commercial product made by the Dutch Process with the following composition.

CONSTITUENT	PER CENT
Moisture	3.00
Ash	7.11
Nitrogen	3.74
Ether soluble material	20.64
Crude fiber	5.25
N. F. E.	40.63

In the first experiments pasteurized fluid milk (Approx. 3.8% butterfat) was fed, while in the later experiments whole milk powder was fed. Details in the experimental procedure are given under each separate experiment.

PRELIMINARY EXPERIMENT

Since no information was available as to whether rats would drink milk containing varying percentages of cocoa, a preliminary experiment was conducted to determine the approximate maximum amount of cocoa that can be added to milk without retarding the rate of growth. Three animals each were placed on a whole milk and on a one per cent chocolate milk diet and one animal each was placed on chocolate milk diets containing respectively 10, 20, and 30 per cent cocoa powder. Fresh, pasteurized, mineralized milk to which seven per cent cane sugar had been added was used for all the diets. The milk was fed *at libitum*. It was found that the daily consumption of chocolate milk by rats decreased as the percentage of cocoa was increased above one per cent. For example the average daily feed consumption during th first week of the experiment was as follows:

No cocoa	35 grams
1% "	35 "
10% "	17 "
20% "	10 "
30% "	7 "

The animals receiving the 30 per cent and 20 per cent chocolate milk died at the end of one week and six weeks, respectively. The animal receiving 10 per cent cocoa in the milk was taken off the experiment after 12 weeks with practically no gain in weight. Animals on the whole milk diet and the one per cent cocoa diet were kept on experiment for 30 weeks, with no significant difference in rate of growth. At the end of the experiment all six animals weighed approximately 400 grams and were extremely fat. The results of this preliminary experiment indicate that rats will make normal growth gains on whole milk and on chocolate milk containing 1 per cent cocoa, but show poor growth and definite injury on milk containing 10 per cent cocoa or more.

FEEDING FLUID CHOCOLATE MILK AD LIBITUM

The purpose of this experiment was to continue the study on the maximum amount of cocoa which may be added to milk without retarding the rate of growth. Twelve male rats, weighing approximately 43 grams each,

TABLE I

Summary of results for first six weeks of experiment

	RATIONS			
	Control	4% cocoa	7% cocoa	10% cocoa
	gm.	*gm.*	*gm.*	*gm.*
Average daily gain	3.45	2.07	0 85	0 04
Average daily feed consumption	53 2	37.3	23.5	16.7
Average daily total solids intake	9.89	8.22	5 75	4.5
Average daily cocoa intake	0	1.49	1.64	1 67

were used in this experiment. The animals were divided into three groups of four rats each. Each group received one of the following four diets: Whole milk without cocoa, and whole milk to which 4, 7, and 10 per cent cocoa was added. The rats were placed in individual cages, which were equipped with Fisher porcelain feed cups and water bottles. All of the
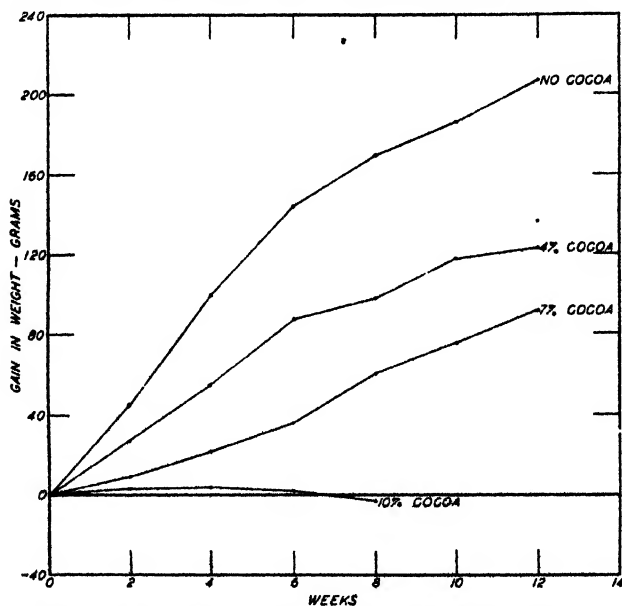
FIG. 1. COMPARATIVE GROWTH OF RATS FED AD LIBITUM MILK CONTAINING VARYING PERCENTAGES OF COCOA.

diets were mineralized and contained seven per cent cane sugar, and were fed ad libitum.

The experiment lasted for 12 weeks, and the results obtained are given in Table I, and Figures 1 and 2. Data in Table I are limited to the first six weeks of the experiment, because two rats on the 10 per cent cocoa ration and one rat on the seven per cent cocoa ration died after seven weeks. The other animals made the following average total gains during the experimental period: control, 208 gms; 4 per cent cocoa, 120 gms; 7 per cent cocoa, 92 gms; and 10 per cent cocoa, no gain. Their rates of growth are shown in Figure 1. Table 1 shows that when chocolate milk varying in cocoa content from 4 to 10 per cent is fed *ad libitum* the average daily gain in weight decreases as the percentage of cocoa in the diet increases. Figure 1 shows graphically these marked differences in weight. An idea of the physical condition of the animals may be gained from Figure 2. The rats had been on experiment for seven weeks at the time the picture was taken. The photograph shows the marked differences in weight and in the appearance of the coats of the animals.

Table I also shows that the daily chocolate milk intake decreases as the percentage of cocoa is increased in the diet. This no doubt is mostly responsible for the inferior growth when cocoa was fed. However it does not seem to account for all of the observed decreases in growth. It should also be noted in the table that the average daily cocoa intake was practically the same for the three concentrations of cocoa. This will be referred to in the discussion of the data.

All animals were autopsied at the close of the experiment or after they had died. In all of the animals the lungs, liver, spleen and the kidneys appeared to be normal. However, the rats receiving the seven, and ten per cent cocoa diets had large masses of what appeared to be undigested cocoa in the ceca. In one case it appeared to be obstructing the whole tract. Furthermore, the feces in the intestinal tract were hard. Gas was found in the stomach, intestinal tract, and cecum. These abnormalities were more pronounced as the cocoa was increased from seven to ten per cent. One rat on the ten per cent cocoa diet showed a possible petechial hemorrhage in the gastric mucosa.

FEEDING COCOA WITH WHOLE MILK POWDER

In this study the cocoa was added to the whole milk powder instead of to fluid milk as in the previous experiments. This feeding procedure has
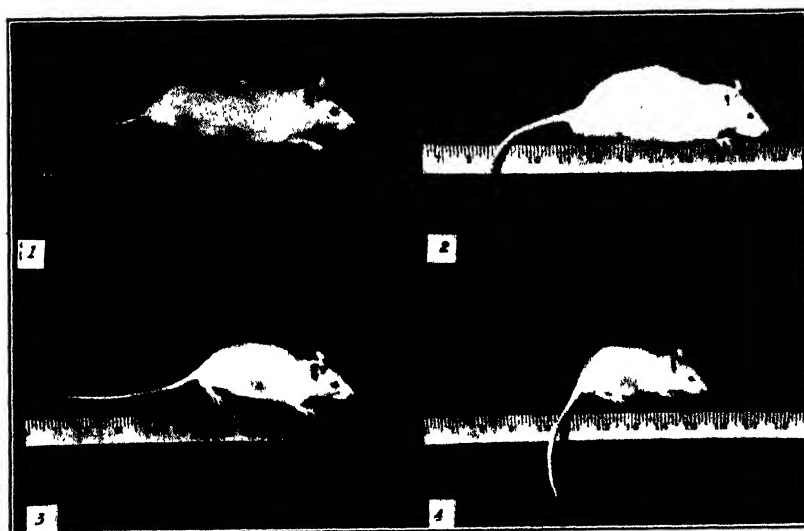
FIG. 2. PHOTOGRAPH OF RATS FED AD LIBITUM MILK CONTAINING DIFFERENT PERCENTAGES
OF COCOA.

TABLE II
Formulae for rat rations

INGREDIENTS	RATION NO.			
	I Per cent	II Per cent	III Per cent	IV Per cent
Cocoa	0	5.0	11.9	17.8
Whole Milk Powder	62.6	59.4	54.5	50.6
Cane Sugar	37.4	35.6	33.6	31.6
Cocoa on Fluid Milk Basis	0	1	2.5	4

the advantage that enough feed can be mixed at one time for the entire experiment. Another advantage for the dried milk plus cocoa is that the cocoa does not settle out as in fluid milk, thus making possible a closer check on the daily consumption of cocoa.

Two experiments were conducted with the dehydrated diet, using a total of forty-eight young rats as subjects. In the first experiment 12 males and 12 females were used, while in the second experiment 8 males and 16 females were used. In each experiment 24 young rats were divided into six groups. Each group of four animals consisted of litter mates of the same sex, and as nearly as possible of the same weight. Up to the time of being placed on the experiment, the rats had received the stock ration of the breeding colony.

Four diets were compounded as shown in Table II, and fed one to each rat in the groups of four individuals, thus there being in each experiment

TABLE III

Average daily gain in weight and daily feed consumption during the experiments

RATION	GAIN IN WEIGHT	GAIN OR LOSS OVER CONTROL	BASIC RATION INTAKE	COCOA INTAKE
	gm.	*gm.*	*gm.*	*gm.*
		Experiment No. 1*		
No cocoa	2.21		6.80	0.00
1% cocoa	2.15	– .06	6.80	0.36
2.5% cocoa	2.02	– .19	6.80	0.92
4% cocoa	1.86	– .35	6.80	1.49
		Experiment No. 2**		
No cocoa	1.85		8.57	0.00
1% cocoa	1.90	+ .05	8.57	0.46
2.5% cocoa	1.74	– .11	8.57	1.16
4% cocoa	1.49	– .36	8.57	1.86

* Experiment No. 1 lasted for six weeks and each datum is an average value for six animals, three males and three females.

** Experiment No. 2 lasted for nine weeks and each datum is an average value for six animals, four females and two males, except for the one male group in which the rat on the 4% cocoa ration died during the fifth week apparently from some respiratory trouble.

six individuals on each of the four treatments. The rats were fed in accord with the principle of paired feeding, however, in this case quadruplets instead of pairs. The four diets were compounded to contain none, one, two and one-half, and four per cent of cocoa respectively and seven per cent cane sugar, on a fluid milk basis. Each rat in a group of four received the same amount of milk powder and cane sugar but had a different cocoa intake. In other words, the only variable in the ration was the percentage of cocoa which was added as an accessory food. The quantity of food given to each group of four rats was determined by the quantity consumed by the individual eating the least within the group. In most instances, the four per cent cocoa diet determined the food intake in all groups.

The rats were individually caged and placed on the experimental diets shortly after weaning. The first experiment was continued for six weeks and the second for nine weeks. The animals were fed once each day and the feed was weighed daily to determine the amount consumed, care being taken to prevent losses. The food was weighed into a Fisher porcelain feed cup of approximately 75 c.c. capacity, which was set in a metal cup and held in place by a metal cover. This arrangement reduced the average spillage per rat during six weeks to approximately two grams. The iron, copper, and manganese were fed daily in amounts as recommended by Elvehjem *et al.* (7), and were added to the milk powder. The rats had water before them all of the time.

The rats were weighed weekly. Bacterial flora studies were made during the latter part of the experiments. At the close of both experiments some of the rats on each diet were autopsied.
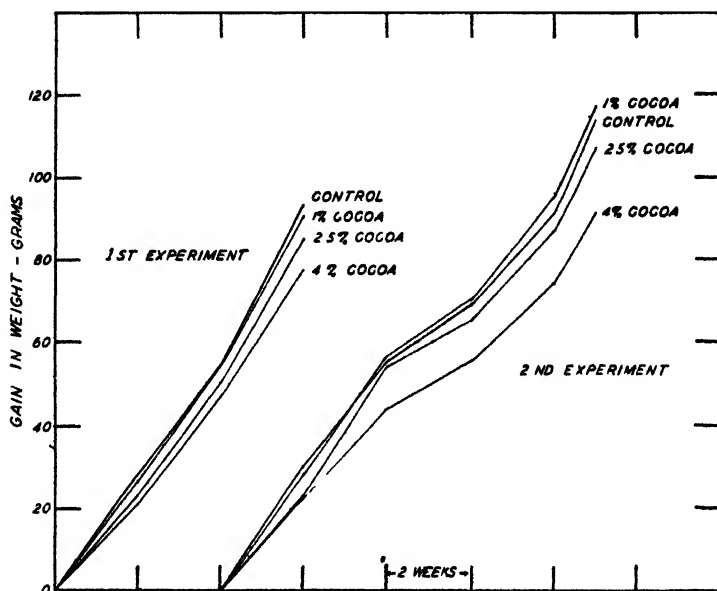
FIG. 3. COMPARATIVE GROWTH OF RATS FED EQUAL AMOUNTS OF THE BASIC RATION BUT VARYING AMOUNTS OF COCOA.

The essential data are given in Table III and Figure 3. Since the rate of growth varies with the sex of the animals, the data were analyzed separately. It was found, as expected, that the females grew more slowly than the males. It was also found that the trend in the rate of growth, both for the control rats and for those receiving varying percentages of cocoa, was practically the same for both sexes. Since the sexes were equally distributed for all rations, the data are presented as averages for male and female.

The growth curves in Figure 3 and the data in Table III for the first experiment show a progressive decrease in rate of growth as the percentage of cocoa is increased up to four per cent. However, decrease in rate of growth is probably not significant until the amount of cocoa is increased to four per cent.

The second experiment was started with two males and four females on each diet. During the fifth week one male on the four per cent cocoa diet died, presumably from a respiratory trouble, thus reducing the male group to one animal on the four per cent diet during the latter part of the experiment. Both male and females grew a little more slowly in the second ex-

periment than they did in the first. The only known difference in the diets of the two experiments was that the whole milk powder was obtained from a different lot in the second experiment. The results obtained in the second experiment are similar to those obtained in the first; namely, that the cocoa must be increased to four per cent before a significant decrease in the rate of growth is obtained. The one per cent cocoa group made slightly better gains than the control, while in the first experiment the reverse was true. However, the differences between the control, one per cent, and 2.5 per cent cocoa diets are not great enough to be of any significance. The autopsies showed no pathological condition in any of the experimental animals.

EFFECT OF COCOA ON THE INTESTINAL FLORA OF ALBINO RATS

A study was made of the intestinal flora of three rats on each of the following diets: Powdered whole milk, powdered whole milk plus 4 per cent cocoa, fluid whole milk, and fluid whole milk plus 1 per cent cocoa. All of the diets were mineralized and seven per cent cane sugar was added. These animals had been on the powdered milk diet for eight weeks and on the fluid milk diet for 30 weeks, when this study was made. A detailed description of the feeding procedure has already been given. Serial dilutions of the feces were plated out on nutrient agar, aerobic and anaerobic, MacConkey's agar, and tomato agar in an atmosphere of carbon dioxide. Egg meat tubes were used to determine the degree of hydrogen sulphide production and putrefaction.

The results obtained indicate that there was no significant difference in the intestinal flora of the rats on the different milk diets. From the differential plate counts it was found that aciduric bacteria strongly predominated over the *Escherichia coli,* anaerobes, and other fecal bacteria. The data obtained from the egg meat tubes showed the presence of putrefactive bacteria in all of the rats. It is probable that the putrefactive bacteria present were *Clostridium welchii,* a common intestinal anaerobe. It is well known that diet has a marked influence on the type of bacteria present in the intestinal tract. As all of the experimental rats were on straight milk diets, it was to be expected that they would all have a similar intestinal flora. Although some of the animals received one and four per cent cocoa in the milk, this amount of cocoa is not enough to make a marked change in the composition of the milk diet, in-so-far as its influence upon the intestinal flora is concerned.

pH determinations were made on the feces of three animals on whole milk diet and three animals on whole milk diet to which one per cent cocoa was added. It was found that the average pH for the cocoa-free diet was 7.32 and for the one per cent cocoa diet was 7.40. It is evident from these fecal pH values that the addition of one per cent cocoa to a straight milk diet has no significant effect on the fecal pH.

DISCUSSION

When chocolate milk was fed *ad libitum* to rats, the daily consumption decreased as the percentage of cocoa was increased above one per cent. It was noted that when feeding *ad libitum* chocolate milk which contained four, seven, and ten per cent cocoa, the daily cocoa intake was nearly the same, being 1.5, 1.6 and 1.7 grams, respectively. In the controlled feeding experiments in which all animals within a group received equal quantities of the basic ration but varying amounts of cocoa, the diet containing the highest percentage of cocoa determined the food intake for all the animals in the group. These results indicate that cocoa limits the consumption of chocolate milk by rats. Two possible reasons for this are first, the cocoa may decrease the palatability of the milk; second, the cocoa may be toxic to rats.

This study has shown that there is a narrow range of cocoa tolerance in rats. One per cent cocoa in milk had no noticeable effect, two and one-half per cent cocoa had a questionable effect, while four per cent cocoa retarded the growth of rats. It is difficult from our present results to determine what specific factors may be responsible for this retardation in growth. The feces in the intestinal tract were very hard when the concentration of cocoa was increased to seven or ten per cent in the diet. Therefore, the effect of cocoa may be mostly a physical one in that the indigestible cocoa fiber tends to block the intestinal tract. Neumann (4) has shown that the protein in cocoa is more digestible in the presence of larger quantities of cacao fat. This suggests that chocolate milk made from whole milk may be more easily digested than that made from skimmilk.

Further study is being made to determine what specific factors are responsible for the observed retardation in growth when four per cent cocoa is added to milk.

SUMMARY AND CONCLUSIONS

The effect of the addition of varying percentages of cocoa to mineralized whole milk was studied by means of growth experiments on a total of 72 albino rats. When fluid chocolate milk containing more than one per cent of cocoa was fed *ad libitum,* the rate of consumption decreased as the percentage of cocoa increased.

When cocoa was added to whole milk powder and the amount fed was controlled, the one per cent cocoa diet was equal to the whole milk diet; the two and one-half per cent cocoa diet gave a questionable retardation rate of growth; and the four per cent cocoa diet definitely retarded growth.

When the rats received the seven and ten per cent cocoa diets, the feces in the intestinal tract were very hard and there was a greater accumulation of food material in the ceca than was the case in the control group.

Studies of intestinal flora showed no distinctive changes for the whole milk, one, and four per cent cocoa diets. The addition of one per cent cocoa to a straight milk diet had no significant effect on the fecal pH.

Since these experiments were conducted with laboratory animals only, no direct application to human nutrition can be made. Assuming, however, that these results may have some application to human nutrition, we may conclude that the cocoa in average commercial chocolate milk which contains a trifle over one per cent cocoa does no harm nor does it enhance the nutritional value of the milk.

The authors wish to express their indebtedness to Dr. H. Rakieten of the Department of Bacteriology and Physiology for performing the autopsies and also to Mr. W. B. Esselen, Jr , of the Nutritional Laboratory, for making the intestinal flora studies.

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THE RELATIONSHIP BETWEEN TEMPERATURE AND OVERRUN IN THE WHIPPING OF ICE CREAM MIXES

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It is the purpose of this paper to present data showing that the whipping capacity of various ice cream mixes can be expressed by straight line equations of the form

$$\% \ Overrun = At + B$$

where t is the temperature in the freezer and A and B are constants, subject to the qualification that each mix, as it approaches complete melting, reaches a maximum possible overrun for that mix; and subject possibly to a further limiting figure, capable as yet of but approximate evaluation, which may describe the stability of the whip to continued beating in the freezer. The whipping capacity of a mix will be slightly different in different freezers but the equation, plus a statement of maximum overrun and stability, will describe the whipping properties of each mix under given freezing conditions. It is believed that this is true of all ice cream mixes of usual composition and treatment, since it held for all of the considerable number of mixes studied.

The relationship of the above information to the usual manufacturing procedure for ice cream is discussed.

INTRODUCTION

The capacity of an ice cream mix to incorporate air in the freezer is one of its most important properties, particularly from the point of view of economy in manufacture. The degree of overrun which is obtainable in a mix is dependent in varying degree upon every variable that enters into the process of manufacture, and since, up to the present time, there has been no way to evaluate adequately the whipping capacity of a mix, information concerning the effects of these variables is in a chaotic state. Work was therefore undertaken to find out if any simple relationship existed between the whipping capacity of a mix and the temperature of the ice cream in the freezer.

Note:—A check of the homogenizer gauge after this paper was in press showed that the actual homogenization pressures must have been lower than recorded. A repetition of a portion of the work showed that the general principles of the paper are correct. As might be expected, the mixes prepared at higher pressures were somewhat more stable than those recorded herein.

EXPERIMENTAL

The best way to determine whether or not there is any relationship between whipping capacity and temperature in an ice cream mix would be to freeze to a definite temperature, whip to either maximum or constant overrun, and compare the figures with the data obtained at different temperatures with other portions of the same mix. To this end the 20-quart Miller brine freezer (dasher speed 180-R. P. M.) was connected through a pump and suitable valves to two brine tanks. The brine in one tank was maintained at a temperature of $-17.8°$ C. ($0°$ F.) or slightly below, and was used to freeze the mix down to the desired temperatures. The brine from the other tank, which was usually brought to a temperature approximately $3°$ C. below that desired in the freezer could then be circulated through the freezer to maintain a constant temperature. A predetermined temperature could not be obtained exactly, but for the purpose of the work any approximate temperature was suitable if it could be maintained. In the course of the work the temperature of the ice cream was measured in the overrun cup. Work carried out a number of years ago comparing such readings with those of a thermocouple within the freezer indicated that, as long as the cold brine did not cause supercooling within the freezer, this method was reliable.

When mixes were frozen in this way it soon became apparent that a definite maximum overrun was attained in the freezer shortly after constant temperature was reached, but that this higher value could not usually be held longer than from 2 to 8 minutes, in spite of the fact that temperatures could be maintained constant practically at will. The ability of a mix to withstand the action of the beaters while at its maximum overrun is apparently an important property of each mix, as will be shown later.

It should be mentioned that Thomas Hall[1] carried out a similar series of experiments upon a mix of 38% total solids and 10.75% butter-fat, but his mix was apparently very stable, for he obtained constant overrun with continued whipping at constant temperature. He also noted that 100% overrun was obtained for this mix at a constant temperature of $-3.25°$ C. even though this temperature was reached in different ways. From this he concluded that temperature and overrun were interrelated, but unfortunately he appears not to have carried the work further.

In plotting overrun against temperature for our data obtained in the above manner, it became evident that a simple straight line relationship existed between overrun and temperature if the temperature was not too high. If a certain temperature, characteristic for each mix, was exceeded, overrun began to fall off rapidly. Some of Hall's data, when re-plotted in this manner also gave straight lines. If temperatures are permitted to go too low, there seems to be a departure from the straight line relationship, the

[1] Thomas Hall, Ice Cream Trade Jour. *20*, no. 10, p. 51, 1924.

overruns being higher than expected. These are temperatures where over-
runs are about 40% or less and are lower than would usually be encountered
in commercial practice. This phase of the subject has not yet been investi-
gated thoroughly.

In Table 1, and Figure 1, data and curves are given showing the rela-
tionships encountered between overrun and temperature for mixes of vary-
ing composition, gelatin content, and homogenization pressure. The data
are not presented as a study of these factors in relation to overrun, although
some interesting relationships are apparent, but rather to show that mixes
of wide variety exhibit a straight line overrun-temperature relationship.
This relationship can be expressed by the equation for a line as follows:

$$\% \ \text{Overrun} = At + B$$

where t is the temperature and A and B are constants. The constant A
indicates the rate of overrun increase with rise in temperature and B locates
the line with relation to the coordinates. In general it could be said that
the greater these constants, the greater the overrun obtainable at a given
temperature, but since a certain overrun cannot be exceeded in each mix
this equation is not a complete description of whipping capacity unless
limited by the statement of the maximum possible overrun that can be
attained in the mix.

The question now arises as to the relation of this information to overrun
data obtained in normal freezings in this same brine freezer. With the fact
in mind that the usual method of freezing ice cream is to freeze down to a
certain point in the freezer and then turn off the brine and whip till the
desired overrun is reached, several portions of each of the mixes reported
above were frozen to different temperatures, the brine was shut off and the
mixes were whipped for a considerable period. Temperature, overrun and
time were recorded throughout this process. It was soon evident that in
every case the temperature-overrun equilibrium line was reached in from
12 to 14 minutes and that this straight line was followed for a period as the
mix continued to warm up. This period was sometimes brief and some-
times long. Then with continued beating the whip broke and the overruns
became lower than called for by the equation of the equilibrium line. This
is shown by the data plotted in Fig. 2, obtained from the 12% butter-fat
mix made up without gelatin, one of the most stable mixes.

In plot A the straight line is given. In the other plots it is dotted in for
reference. Plot B is for a freezing in which the brine was turned off at
a comparatively high temperature. It is seen that the overrun-temperature
curve reaches the equilibrium line at about its mid-point and follows it to
its maximum. In plot C the mix is frozen to a lower temperature, reaching
the line at about 78% overrun and following it to nearly 120% overrun,
when the overrun drops with further increase in temperature. In Plot D

PERCENT OVERRUN
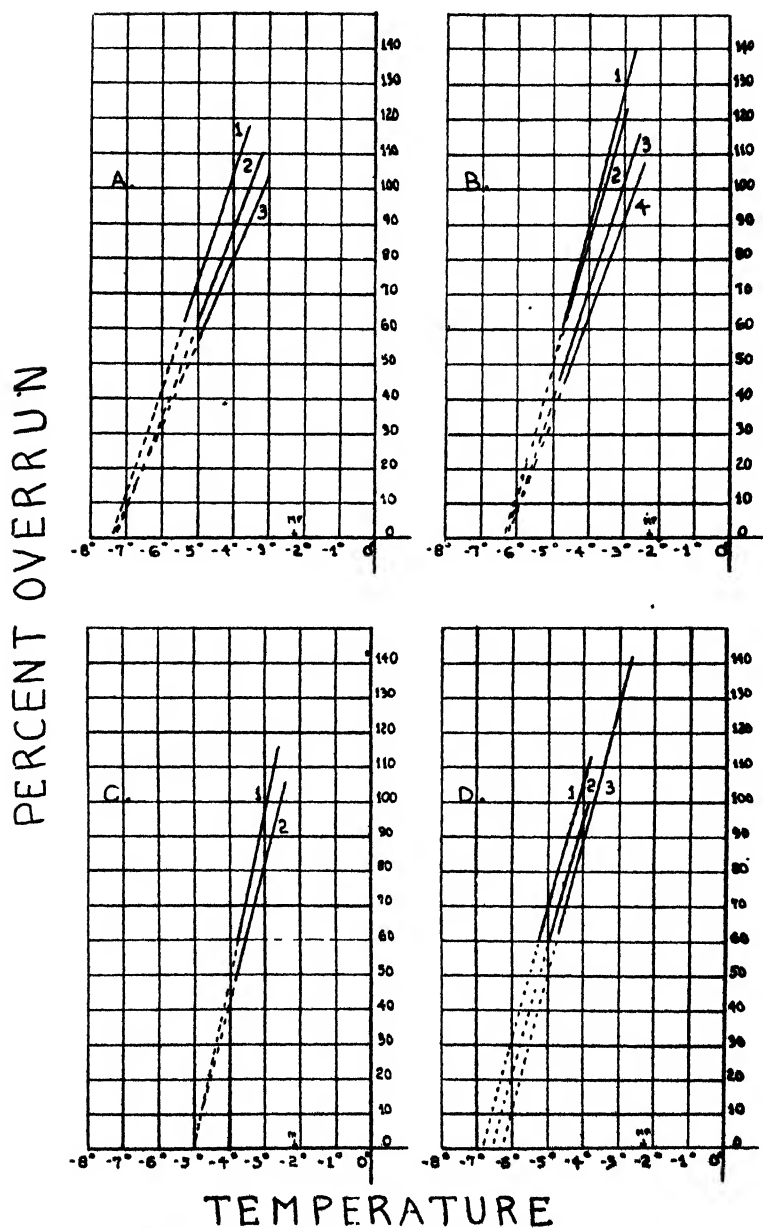
TEMPERATURE

FIGURE 1. RELATIONSHIPS BETWEEN OVERRUN AND TEMPERATURE FOR ICE CREAM MIXES OF VARYING COMPOSITION, GELATIN CONTENT AND HOMOGENIZATION PRESSURE.

TABLE 1

Relationships between overrun and temperature for ice cream mixes of varying composition, gelatin content and homogenization pressure

A. Mixes of 8% butter fat, 10% milk solids not fat and 14% sugar, 2500 lb. homogenization pressure.

1.—No gelatin		2.—0.3% gelatin		3.—0.5% gelatin	
Overrun	Temp. C.	Overrun	Temp. °C.	Overrun	Temp. °C.
110	− 3.80	98	− 3.50	97	− 3 20
99	− 4.10	93	− 3.80	90	− 3.50
91	− 4.50	85	− 4.10	82	− 3.90
96	− 4.60	80	− 4.40	70	− 4.50
75	− 5.00	76	− 4.50	60	− 4.90
66	− 5.20	70	4.60		

% Overrun = 30.7t + 227	% Overrun = 27.0t + 195	% Overrun = 24.2t + 178
Max O. R. 115%	Max. O. R. 108%	Max. O. R. 105%

B. Mixes of 12% butter fat, 10% milk solids-not fat and 14% sugar, 2500 lb. homogenization pressure

1.- No gelatin		2 – 0.1% gelatin		3. 0.3% gelatin		4.—0.5% gelatin	
% Overrun	Temp. C	% Overrun	Temp °C.	% Overrun	Temp °C.	% Overrun	Temp. °C.
140	− 2.75	118	− 3.20	115	− 2.70	98	− 2.85
132	− 3.10	99	− 3.55	100	− 3.10	88	− 3.20
119	− 3.35	86	4.00	90	− 3.30	85	− 3.30
92	− 3.90	77	− 4.30	81	− 3.60	75	− 3.60
83	− 4.10	59	− 4 80	68	− 4.10	64	− 3.90
62	− 4.80			46	− 4.65	48	− 4.60

% Overrun = 38.8t + 245	% Overrun = 35.8t + 232	% Overrun = 29.4t + 189	% Overrun = 28.1t + 178
Max. O. R. 143%	Max. O. R. 125%	Max. O. R. 115%	Max. O. R. 109%

C. Mixes of 16% butter-fat, 8% milk-solids not-fat and 14% sugar, 2500 lb. homogenization pressure.

% Overrun	Temp. °C.	% Overrun	Temp. °C.
115	− 2.75	100	− 2.60
109	− 2.85	95	− 2.70
96	− 3.10	82	− 2.90
85	− 3.30	64	− 3.60
69	− 3.50	50	− 3.90
60	− 3.80		

% Overrun = 48.5t + 240	% Overrun = 40.0t + 202.5
Max. O. R. 118%	Max. O. R. 107%

D. Mixes of 12% butter-fat, 10% milk-solids-not-fat, 14% sugar and no gelatin.

1.—3500 lb. H. P.		2.—2500 lb. H. P.*		3.—1500 lb. H. P.	
% Overrun	Temp. °C.	% Overrun	Temp. °C.	% Overrun	Temp. °C.
111	− 3.80	140	− .275	98	− 3.90
98	− 4.20	132	− 3.10	88	− 4.30
81	− 4.80	119	− 3.35	76	− 4.40
74	− 4.90	92	− 3.90	60	− 5.00
65	− 5.10	83	− 4.10		
		62	− 4.80		

% Overrun = 36.4t + 252	% Overrun = 38.8t + 245	% Overrun = 36.4t + 243
Max. O. R. 118%	Max. O. R. 143%	Max. O. R. 102%

* Data from Series B No. 1.
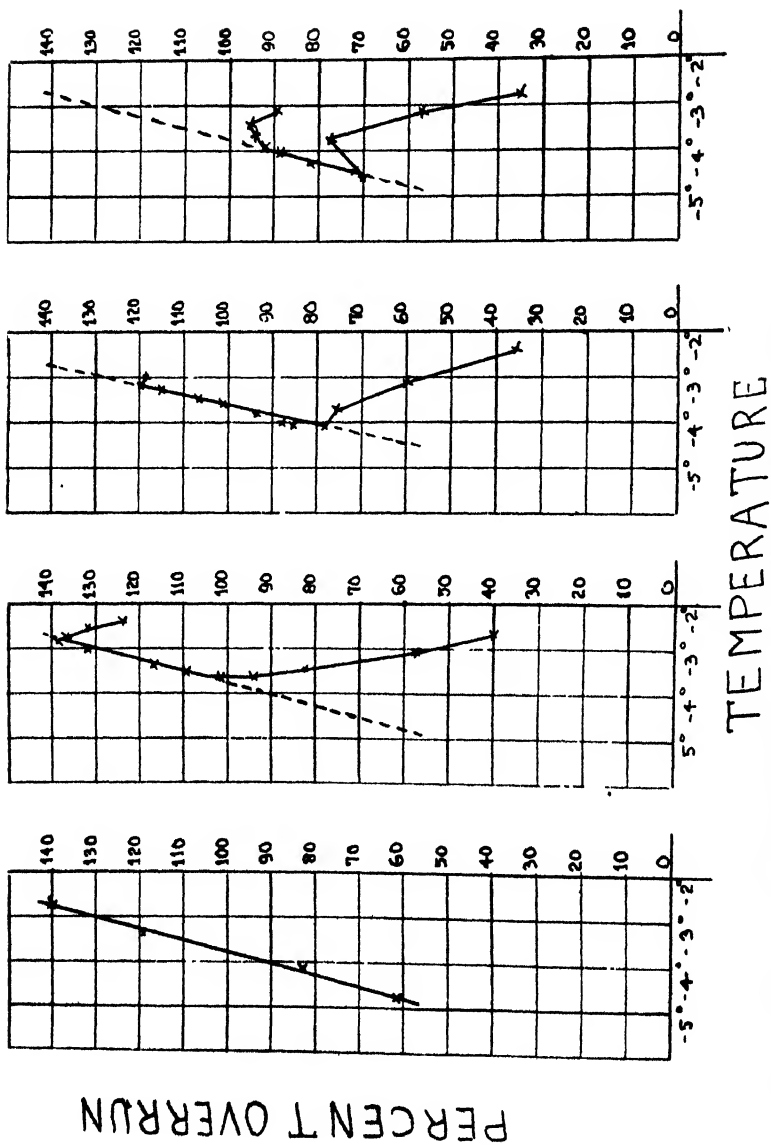
FIG. 2. FREEZING DATA FOR THREE PORTIONS OF A NORMAL ICE CREAM MIX IN RELATION TO THE OVERRUN-TEMPERATURE EQUILIBRIUM LINE.

the line is reached at a somewhat lower overrun and is not followed so far before the break occurs. The complete data are given in Table 2.

TABLE 2

Freezing data for three portions of a normal ice cream mix

(See Fig. 2)

B

Time (Min.)	4	6*	8	10	12	14	16	18	20	22	24	26
Overrun	40	57	82	94	102	109	117	132	138	134	131	123
Temp. °C.	−2.7	−3.1	−3.5	−3.7	−3.6	−3.5	−3.35	−3.1	−2.9	−2.8	−2.6	−2.4

C

Time (Min.)	4	6*	8*	10	12	14	16	18	20	22	24	26
Overrun	37	60	76	78	85	88	94	101	107	115	119	118
Temp. °C.	−2.4	−3.1	−3 75	−4.1	−4.2	−4.1	−3.9	−3.7	−3.55	−3.35	−3.1	−3.0

D

Time (Min.)	4	6	8	10*	12	14	16	18	20	22	24
Overrun	35	37	78	72	70	82	88	92	94	96	89
Temp. °C.	−2.8	−3.2	−3.8	−4.5	−4.6	−4.25	−4.1	−3.9	−3.7	−3.4	−3.2

* Indicates time brine was turned off.

In some of the other tests, when the freezings were carried to lower temperatures, the equilibrium line was reached before the brine was shut off. In such cases the line was followed down and back again as the temperature fell and rose. One low butter-fat mix with 0.5% gelatin, made from old condensed milk, was very unstable, as was the normal mix homogenized at 1500 pounds pressure. With these mixes it was impossible to stay on the equilibrium line for more than two minutes, that is, instability occurred when the mixes had been in the freezer for about fourteen minutes. Usually, however, departure from normal equilibrium did not occur until mixes had been in the freezer from 22 to 26 minutes. The stability of the different mixes may perhaps be expressed by indicating the number of minutes they are stable in the freezer under given freezing conditions but more work must be done upon this subject before final suggestions can be made.

That the instability is due to the action of the beaters seems to be shown conclusively by the fact that it was possible to freeze a mix to a low temperature, and, by passing comparatively warm brine through the freezer, to warm it up rapidly, and describe the complete equilibrium line before instability occurred.

The figures show conclusively that the straight line equilibrium curve between temperature and overrun is attained in this freezer during normal freezing if the mix is whipped long enough, and that the following of the curve for a period with rise in temperature is conditioned only by the stability of the mix to the continued action of the beaters.

To make sure that these relationships were not peculiar to this brine freezer, a considerable number of freezings were also carried out in a rapid freezing 20-quart direct expansion ammonia freezer with dasher speed of 200–R. P. M.

The same straight line temperature-overrun relationships were found with this freezer, but overruns were slightly higher, from 3 to 7%, and stability markedly less, so much so, that with a normally stable mix it was impossible to follow the straight line in whipping back, and a mix that was stable in the brine freezer for 22 to 26 minutes was stable in this freezer for only 12 to 14 minutes. It was found that stability could be imparted to the mix by freezing slowly, that is, by retarding the rate of evaporation of the ammonia. These phenomena are being investigated in detail and will be the subject of a future paper.

CONCLUSIONS

An equilibrium between temperature and the overrun obtainable in the freezing of ice cream mixes has been shown to exist. The equation of this relationship is that of a straight line. The equation must be qualified by stating the maximum overrun that can be attained in the mix, and probably further by a figure indicating the stability of the mix under the conditions of freezing. This figure would perhaps be a statement of the number of minutes that the mix could be beaten in the freezer before instability resulted. A departure from this equilibrium curve occurs also if mixes are frozen to too low a temperature.

By means of this information it is possible to express the whipping capacities of ice cream mixes and to evaluate differences brought about by the variation of factors incident to ice cream manufacture. The ice cream manufacturer may thus see how to control his freezings accurately and thus obtain the desired overrun in the shortest possible time. The information may also be applicable to the designing of freezers for the best performance.

American Dairy Science Association Announcements

B. W. HAMMER PANEGYRIC

It is gratifying to learn that former students of Doctor Hammer are honoring him at the completion of 25 years of distinguished service at Iowa State College. Professor C. B. Lane, chairman of the Hammer Commemoration Committee has written the following announcement letter to the editor and it will be of interest to all readers of the JOURNAL OF DAIRY SCIENCE.

"Doctor B. W. Hammer, Professor and Head of Dairy Bacteriology at the Iowa State College, has completed twenty-five years of distinguished service to dairy science and to the dairy industry in general. Subsequent to graduation from the University of Wisconsin Doctor Hammer continued his studies there under Doctor E. G. Hastings and was Assistant in Agricultural Bacteriology from 1908–1909. Then he was Bacteriologist, associated with Doctor M. P. Ravenel at the Wisconsin State Hygienic Laboratory at the University of Wisconsin, from 1909 to 1911, after which he joined the Dairy Industry Department at the Iowa State College in 1911. Since 1916 he has been in his present position as Head of Dairy Bacteriology at the Iowa Agricultural Experiment Station and Professor of Dairy Bacteriology. He managed to find time from a busy academic life to continue graduate study and research, and in 1920, he was awarded the degree Doctor of Philosophy from the University of Chicago.

"It is unnecessary to cite the significant contributions of Doctor Hammer in the field of Dairy Bacteriology and Chemistry; his revelations of important biological and chemical processes, significant in butter and other dairy products, are well known to those connected with dairy research or commercial dairying. Teaching, both graduate and under-graduate, must also be a pleasure to him, otherwise it is difficult to see how he can teach so effectively and excellently.

"To commemorate the occasion of Doctor Hammer's twenty-fifth anniversary his former students have written and published the 'B. W. Hammer Panegyric,' a volume primarily composed of original scientific treatises relating to dairy manufacture, bacteriology and chemistry. The volume contains 27 treatises by as many students and, in addition, several tributes by persons well known in the industry.

"The committee takes pleasure in announcing to you this significant anniversary and the publication of the Panegyric. Copies may be obtained at $2.50 each by ordering from the Collegiate Press, Inc., Iowa State College, or from C. B. Lane, Dairy Industry Department, Iowa State College."

Very truly yours,
C. B. Lane, Chairman
Hammer Commemoration Committee.

AMERICAN DAIRY SCIENCE ASSOCIATION

The Thirty-second Annual Meeting

Agricultural College Campus, University of Nebraska

Lincoln, Nebraska—June 21–25, 1937

GENERAL PROGRAM

Monday, June 21

1 P. M.–9 P. M.	General registration and room registration, Dairy Industry Building.

Tuesday, June 22

8 A. M.–9 P. M.	General registration and room registration, Dairy Industry Building.
12 NOON–1 P. M.	Lunch hour.
1:30 P. M.–4:30 P. M.	Ice Cream Judging Conference, Room 204, Dairy Industry Building.

H. W. Gregory, Chairman, Purdue University.
A. C. Dahlberg, Judge, New York Agricultural Experiment Station.

1:30 P. M.–4:30 P. M.	Reproduction Symposium, Dairy Barn.

The Rôle of the Hormones in Reproduction with Special Reference to the Female Sex Hormones.
T. S. Sutton, Ohio State University.
The Preparation, Properties, and Use of Gonad-Stimulating Hormones.
L. E. Casida, University of Wisconsin.
Trichomoniasis Review.
L. Van Es, University of Nebraska.
Artificial Insemination—Demonstration.
H. P. Davis and George W. Trimberger, University of Nebraska.

4:30 P. M.	Inspection of dairy barns and the dairy herd.
5:00 P. M.	Meeting of the Board of Directors, Room 207, Dairy Industry Building.
8:30 P. M.	Reception to members and guests by the University of Nebraska, Carrie Belle Raymond Hall, 540 North 16th Street.

Wednesday, June 23

8 A. M.–12 NOON	General registration and room registration, Dairy Industry Building.
8 A. M.–9:30 A. M.	Sectional Committee Meetings.

MANUFACTURING

Chemical Methods for the Analysis of Milk and Dairy Products, Room 301, Dairy Industry Building.

L. C. Thomsen (Chairman).

Dairy Products Quality, Room 207, Dairy Industry Building.

W. H. E. Reid (Chairman).

Bacteriological Methods for the Analysis of Milk and Dairy Products, Room, 303, Dairy Industry Building.

H. Macy (Chairman).

Judging Dairy Products, Room 204, Dairy Industry Building.

H. W. Gregory (Chairman).

Revision of Score Cards for the Sanitary Inspection of Dairy Farms and Milk Plants, Room 206, Dairy Industry Building.

C. J. Babcock (Chairman).

Methods of Determining the Curd Tension of Milk, Room 101, Animal Husbandry Hall.

L. H. Burgwald (Chairman).

Feasibility of Establishing and Maintaining a Loose-leaf Manual of Laboratory Methods, Room 303, Dairy Industry Building.

H. Macy (Chairman).

PRODUCTION

Breeds Relations, Room 205, Animal Husbandry Hall.

S. M. Salisbury (Chairman).

Student Judging Contest, Room 103, Animal Husbandry Hall.

I. W. Rupel (Chairman).

Measuring Results of Pasture Investigations, Room 208, Animal Husbandry Hall.

R. H. Lush (Chairman).

Methods of Experimentation and Analysis, Room 208-A, Dairy Industry Building.

A. E. Perkins (Chairman).

8 A. M.–9 : 30 A. M. Inspection of Extension Exhibits, Room 102, Animal Husbandry Hall.

9 : 00 A. M.–12 NOON Special Recreation for Children, College Activities Building.

9 : 30 A. M.–12 NOON General Session, College Activities Building.

R. R. Graves, presiding.

Address of Welcome.

E. A. Burnett, Chancellor, University of Nebraska.

Presidential Address.

R. R. Graves, Bureau of Dairy Industry, U. S. D. A.

The Eleventh World's Dairy Congress.

J. C. Marquardt, New York Agricultural Experiment Station.

A Teacher Interprets Research.

> W. H. Morton, University of Nebraska.

Breeding and Feeding Dairy Cattle in Denmark.

> H. Wenzel Eskedal, Landøkonomisk Forsøgslaboratorium, Copenhagen, Denmark

12 NOON–1 P. M.   Lunch.

1 : 30 P. M.–4 P. M.   A tour for ladies of the Fine Arts Department and the University Art Gallery has been arranged to be conducted by a member of the Fine Arts staff. This will be followed by a tour of the University Natural History Museum including the Hall of the Elephants conducted by a member of the museum staff. Meet at Morrill Hall, 14th and U Sts.

1 : 30 P. M.–4 : 15 P. M.   Special recreation for children, College Activities Building.

1 P M.–4 · 15 P. M.   Production Section, Room 303, Dairy Industry Building.

> Dairy Management and Physiology.

Manufacturing Section, Room 204, Dairy Industry Building.

> Bacteriology.

Manufacturing Section, Room 301, Dairy Industry Building.

> Ice Cream and Milk By-products.

Extension Section, Room 208, Animal Husbandry Hall.

> Sire and Feed Committees.

4 : 15 P. M.   Visit to University Natural History Museum—Elephant Hall, Morrill Hall, City Campus.

8 : 30 P. M.   Entertainment, College Activities Building.

Thursday, June 24

8 : 00 P. M.–12 NOON   Production Section, Room 303, Dairy Industry Building.

> Feeding.

Manufacturing Section, Room 301, Dairy Industry Building.

> Butter.

Extension Section, Room 208, Animal Husbandry Hall.

> Exhibits and Testing Committee.

9 : 00 A. M.–12 NOON   Special recreation for children, College Activities Building.

12 NOON–1 P. M.   Lunch for men, compliments of Dairy Husbandry Department, College Activities Building.

1 : 30 P. M.   Ladies tour of Nebraska State Capitol and tea.

1 : 30 P. M.–4 : 15 P. M.   Special recreation for children, College Activities Building.

1 P. M.–4 : 15 P. M.	Production Section, Room 303, Dairy Industry Building.
	Vitamins.
	Manufacturing Section, Room 301, Dairy Industry Building.
	Cheese.
	Extension Section, Room 208, Animal Husbandry Hall.
	Four H Club and Quality Committees.
	Instruction Section, Room 204, Dairy Industry Building.
4 : 15 P. M.	Visit to Nebraska State Capitol.
4 : 15 P. M.	Committee meetings.
6 : 30 P. M.	Annual Banquet followed by cards and dancing at Lincoln Hotel.

Friday, June 25

8 A. M.–10 A. M.	Production Section, Room 303, Dairy Industry Building.
	Business Meeting.
	Genetics.
	Manufacturing Section, Room 301, Dairy Industry Building.
	Business Meeting.
	Chemistry and Economics.
	Extension Section, Room 208, Animal Husbandry Hall.
	Business Meeting.
	American Dairy Cattle Club.
10 A. M.–12 NOON	General Session, College Activities Building.
	Business Session.
	Borden Awards.
	Resumé of awards by chairman of committees.
	H. B. Ellenberger—for production.
	H. A. Ruehe—for manufacturing.
	Presentation of awards and medals by representative of Borden Company.
	Speeches on work by recipients of awards.

SECTION PROGRAMS

EXTENSION SECTION

Wednesday morning, June 23

C. W. BLACKMAN, *Chairman*

Program Committee Extension Section

Earl Shultz, Iowa State College, E. J. Perry, New Jersey College of Agriculture, and M. L. Flack, Chairman, University of Nebraska.

8 A. M.–9 : 30 A. M.—INSPECTION OF EXHIBITS

Room 102, Animal Husbandry Hall

J. W. LINN, *Chairman*

Wednesday afternoon, June 23

1 P. M.–3 P. M.—SIRE COMMITTEE REPORT

Room 208, Animal Husbandry Hall

J. F. KENDRICK, *Chairman*

E1—Conducting organized dairy cattle breeding programs through bull associations. R. G. Connelly, Virginia Polytechnic Institute.
Discussions by 1. C. S. Rhodes, University of Illinois.
2. S. J. Brownell, Cornell University.
3. Ivan H. Loughary, University of Idaho.
4. E. A. Gauntt, New Jersey College of Agriculture.
E2—Dairy sire exchange lists. Warren Gifford, University of Missouri.
Discussions by 1. J. G. Hays, Michigan State College.
2. G. W. Vergeront, University of Wisconsin.
3. O. J. Hill, State College of Washington.
4. Floyd Arnold, Iowa State College.
E3—Using D. H. I. A. records in conducting dairy cattle breeding programs. E. E. Heizer, Ohio State University.
Discussions by 1. S. J. Brownell, Cornell University.
2. Gordon Dickerson, University of Wisconsin.
3. Jay L. Lush, Iowa State College.
E4—Forum: D. H. I. A. identification and permanent record project. J. H. Kendrick, Bureau of Dairy Industry, U. S. D. A.

3:00 P. M.–4:15 P. M.—FEEDING COMMITTEE REPORT

Room 208, Animal Husbandry Hall

R. E. HORWOOD, *Chairman*

E5—A feed insurance program with trench silos. V. L. Gregg, University of Arkansas.
E6—An extension program in dairy cattle feeding and feed crop production. K. L. Turk and W. T. Crandall, Cornell University.
E7—Establishing and conducting a dairy pasture improvement program in Missouri. M. J. Regan, University of Missouri.
E8—A new method for conducting a feed meeting. J. G. Hays, Michigan State College.

EXTENSION SECTION

Thursday morning, June 24

8 A. M.–9:30 A.M.—EXTENSION EXHIBITS

Room 102, Animal Husbandry Hall

J. W. LINN, *Chairman*, Kansas State College
J. G. HAYS, Michigan State College

R. A. Cave, South Dakota State College
Don Corbett, University of Maine.
M. L. Flack, University of Nebraska

Exhibits from several states showing dairy extension methods in teaching will be on display with explanatory labels during the entire meeting. The above committee and specialists will be present during this period to discuss and explain the exhibits from their own states.

9:30 A.M.–12 NOON—TESTING COMMITTEE REPORT

Room 208, Animal Husbandry Hall

FLOYD JOHNSON, *Chairman*

E9—Subsidizing testing from the state office. J. W. Linn, Kansas State College.
E10—Subject matter included in testers' training courses. Floyd J. Arnold, Iowa State College.
E11—Getting permanent records filled out for dairy herd improvement association members. C. R. Gearhart, Pennsylvania State College.
E12—What can be eliminated from the tester's work to make possible newer developments. A. B. Nystrom, Bureau of Dairy Industry, U. S. D. A.
E13—Uniform rules governing the operation of dairy herd improvement associations. Floyd Johnston, Iowa State College.
E14—Dairy herd improvement association publicity. E. C. Scheidenhelm, Michigan State College.

EXTENSION SECTION

Thursday afternoon, June 24, 1 P. M.–4 P. M.

Four H Club Committee Report, Room 208, Animal Husbandry Hall

G. M. HARRIS, *Chairman*

E15—Methods of financing 4–H dairy calf club members. J. W. Linn, Kansas State College.
E16—Applying the Danish system of judging to dairy 4–H club work. D. M. Seath, Kansas State College, and G. M. Harris, University of Kentucky.
E17—4–H club demonstrations for improvement of quality. E. A. Gauntt, New Jersey College of Agriculture.

Quality Committee Report

C. J. BABCOCK, *Chairman*

E18—A quality improvement project for milk and cream. C. J. Babcock, Bureau of Dairy Industry, U. S. D. A.

Discussion by C. A. Smith, Colorado State College.

E19—Outline of Colorado quality improvement project. C. A. Smith, Colorado State College.

EXTENSION SECTION

Friday morning, June 25, 8 A. M.–10 A. M.

Room 208, Animal Husbandry Hall

C. L. BLACKMAN, *Chairman*

Business session

E20—American Dairy Cattle Club. J. Rockerfeller Prentice, President of American Dairy Cattle Club.

INSTRUCTION SECTION

Thursday afternoon, June 24, 1 P. M.–4: 15 P. M.

Room 204, Dairy Industry Building

C. Y. CANNON, *Presiding*

(Papers limited to 12 minutes)

I1—Trends in dairy instruction. C. E. Wylie, University of Tennessee.

I2—Junior colleges and their influence on dairy education. C. L. Roadhouse, University of California.

I3—Factors in the retention of knowledge. E. N. Hansen, Iowa State College.

I4—Rapid calculation of rations by means of a pony. P. T. Dix Arnold, University of Florida.

I5—College creameries. Thomas B. Harrison and C. E. Wylie, University of Tennessee.

I6—A course in milk and public health. H. O. Henderson, University of West Virginia.

5-MINUTE REST PERIOD

I7—The desirability of an advanced course in dairy industry as a requirement for agricultural students. Kenneth M. Renner, Texas Technological College.

I8—Extramural courses in dairy husbandry. H. A. Ruehe, University of Illinois.

I9—Undergraduate dairy seminar. A. A. Borland, Pennsylvania State College.

I10—Practical dairy industry experience and the scholastic record. E. F. Goss, Iowa State College.

I11—The placement of dairy graduates. M. Mortensen, Iowa State College.

MANUFACTURING SECTION

Wednesday afternoon, June 23, 1 P. M.–4:15 P. M.

Room 204, Dairy Industry Building

H. Macy, *Presiding*

BACTERIOLOGY

(Papers limited to 12 minutes)

M1—The isolation of the citric acid fermenting streptococci from butter cultures. H. C. Olson, Iowa State College.

M2—The correlation between the organisms found microscopically in butter serum and the grade of cream from which the butter was made. Theodore Hedrick, Montana State College.

M3—The detection of mastitis by the brom-thymol-blue test, leucocyte count, and the microscopic examination of milk. A. C. Fay, H. W. Cave and F. W. Atkeson, Kansas State College.

M4—A combined pasteurizer, cooler and incubator for mother starter. G. H. Wilster and F. E. Price, Oregon State Agricultural College.

M5—Studies upon a bacteriophage inhibitory to *Streptococcus lactis.* F. E. Nelson, University of Minnesota, and B. W. Hammer, Iowa State College.

M6—The dye concentration in culture media employed for the analyses of Escherichia-aerobacter members in milk. H. D. McAuliffe and A. A. Borland, Pennsylvania State College.

5-MINUTE REST PERIOD

M7—The effect of salts on the growth of bacteria in milk. C. S. Mudge and T. G. Anderson, University of California.

M8—Comparative studies on bacterial milk counts in various types of media incubated at 20°, 30°, and 37° C. J. Drexel Dennis and Harry H. Weiser, Ohio State University.

M9—A study of comparative methods and media used in the microbiological examination of creamery butter—I. Yeast and mold counts. G. W. Shadwick, Jr., Beatrice Creamery Co.

M10—Proposed standard for the yeast and mold count of salted butter made from sour cream. E. H. Parfitt, Purdue University.

M11—Studies on *Oospora lactis.* H. Macy and D. L. Gibson, University of Minnesota.

M12—*Pseudomonas fragi* and its importance in dairy products. H. F. Long and B. W. Hammer, Iowa State College.

MANUFACTURING SECTION

Wednesday afternoon, June 23, 1 P. M.–4:15 P. M.

Room 301, Dairy Industry Building

P. H. Tracy, *Chairman*

ICE CREAM AND MILK BY-PRODUCTS

(Papers limited to 12 minutes)

M13—The manufacture of sweetened condensed whey and its use in foods. G. A. Ramsdell and B. H. Webb, Bureau of Dairy Industry, U. S. D. A.

M14—The manufacture of non-foaming casein. G. A. Richardson, N. P. Tarassuk and L. B. Fry, University of California.

M15—Flexible milk plants. W. E. Guest and R. W. Balderston, W. E. Guest and Co.

M16—Sonic homogenization of milk and of ice cream mixes. Leslie A. Chambers, Eldridge Reeves Johnson Foundation, University of Pennsylvania.

M17—A suggested method of evaluating homogenization efficiency by improved photomicrography. A. W. Farrall and R. L. Hanson, Creamery Package Manufacturing Co.

M18—A simplified solids tester for ice cream. Kenneth M. Renner, Texas Technological College.

5-MINUTE REST PERIOD

M19—Effect of certain salts on properties of ice cream mixes. J. I. Keith, C. W. Rink and Earl Weaver, Oklahoma A. & M. College.

M20—Power requirements for freezing ice cream. W. J. Caulfield, C. K. Otis and W. H. Martin, Kansas State College.

M21—Sogo ice cream. Thos. B. Harrison and C. E. Wylie, University of Tennessee.

M22—Flavor defects encountered in strawberry ice cream prepared with commercial dry skim milk and condensed milk from stainless steel pans. E. W. Bird, J. J. Willingham and C. A. Iverson, Iowa State College.

M23—Some factors affecting the serving and dipping qualities of ice creams. W. H. E. Reid and W. S. Arbuckle, University of Missouri.

MANUFACTURING SECTION

Thursday morning, June 24, 8 A. M.–12 NOON

Room 301, Dairy Industry Building

P. H. TRACY, *Chairman*

BUTTER

(Papers limited to 12 minutes)

M24—Volumetric method for determination of diacetyl. H. A. Ruehe and W. J. Corbett, University of Illinois.

M25—The influence of heated testers and composite tests on the Babcock test. P. S. Lucas, Michigan State College.

M26—Removal of French weed flavor from cream. W. B. Combs and S. T. Coulter, University of Minnesota.

M27—Effect of temperature on the rate of deterioration of cream.   W. H. Martin, A. C. Fay and W. J. Caulfield, Kansas State College.

M28—Some aspects of the reduction of acidity in cream for the manufacture of butter.   E. W. Bird, N. E. Fabricius and D. F. Breazeale, Iowa State College.

M29—Studies on the keeping quality of butter made from sour cream.   J. C. Flake and E. H. Parfitt, Purdue University.

5-MINUTE REST PERIOD

M30—Notes on problems confronting the industry on quality improvement of creamery butter.   M. E. Parker, Beatrice Creamery Co.

M31—Overcoming the gummy body of butter caused by feeding cottonseed meal.   J. I. Keith, C. W. Rink and A. H. Kuhlman, Oklahoma A. & M. College.

M32—The lactic acid content in butter.   B. E. Horrall and W. F. Epple, Purdue University.

M33—The pH range of centralizer butter.   W. H. Brown and E. H. Parfitt, Purdue University.

MANUFACTURING SECTION

Thursday afternoon, June 24, 1 P. M.–4: 15 P.M.

Room 301, Dairy Industry Building

P. H. TRACY, *Chairman*

CHEESE

(Papers limited to 12 minutes)

M34—Microflora of cheese slime.   H. Macy and J. A. Erekson, University of Minnesota.

M35—Making cheddar cheeses from low curd tension milk.   J. C. Marquardt and G. J. Hucker, New York Agricultural Experiment Station.

M36—Curd tension measurements.   L. H. Burgwald and T. V. Armstrong, Ohio State University.

M37—The effect of varying storage temperatures and the effect of coverings on the ripening of cheddar cheese.   W. G. McCubbin and E. L. Reichart, University of Nebraska.

M38—Cheese freezing and curing investigations.   J. C. Marquardt, New York Agricultural Experiment Station.

M39—Studies relative to an open flame method for determining the moisture content of cheddar cheese.   I. A. Gould, Michigan State College.

M40—Homogenization of milk for blue cheese.   C. B. Lane and B. W. Hammer, Iowa State College.

5-MINUTE REST PERIOD

M41—Studies on the ripening of blue or American Roquefort cheese.   S. T. Coulter, W. B. Combs and Spencer George, University of Minnesota.

M42—Studies on the ripening of blue cheese. C. B. Lane and B. W. Hammer, Iowa State College.

M43—The influence of steapsin on the rate of ripening blue or American Roquefort cheese. W. B. Combs and S. T. Coulter, University of Minnesota.

M44—A photomicrographic study of processed cheese. Hugh L. Templeton, University of Wisconsin.

M45—Influence of manufacturing methods upon the acidity of brick cheese. D. W. Spicer and Walter V. Price, University of Wisconsin.

M46—Relation between acid defects and hydrogen ion concentration in brick cheese. W. V. Price and D. W. Spicer, University of Wisconsin.

MANUFACTURING SECTION

Friday morning, June 25, 8 A. M.–10 A. M.

Room 301, Dairy Industry Building

P. H. TRACY, *Chairman*

Business Meeting

CHEMISTRY AND ECONOMICS

(Papers limited to 12 minutes)

M47—Bound water and its relation to dairy products. Harry Pyenson and C. D. Dahle, Pennsylvania State College.

M48—The phosphatase test for the efficiency of pasteurization. A. B. Storrs and L. H. Burgwald, Ohio State University.

M49—The significance of ammonia in milk: a practical method for its determination. A. E. Perkins, Ohio Agricultural Experiment Station.

M50—The application of Ritter's test for the detection of copper in milk and dairy products. Jules Turgeon, V. C. Stebnitz and H. H. Sommer, University of Wisconsin.

M51—Production regulations necessary to supply the milk market. B. B. Derrick, Maryland and Virginia Milk Producers Association.

PRODUCTION SECTION

Wednesday afternoon, June 23, 1 P. M.–4:15 P. M.

Room 303, Dairy Industry Building

F. W. ATKESON, *Chairman*

DAIRY MANAGEMENT

(Papers limited to 12 minutes)

P1—A study of the methods of sampling milk for butterfat tests where a combine milker is used. K. S. Morrow and H. C. Moore, University of New Hampshire.

P2—Changes occurring in the freshening dates from year to year of cows in Iowa testing associations. C. Y. Cannon and D. L. Espe, Iowa State College.

P3—A new visible system of dairy herd books. F. W. Atkeson and H. W. Cave, Kansas State College.

P4—Estimating live weight from chest girth of dairy cattle of unknown age. S. Brody and A. C. Ragsdale, University of Missouri. H. P. Davis, University of Nebraska.

PHYSIOLOGY

P5—Is the calcium : phosphorus ratio of common mineral mixtures suited to dairy cattle? G. Bohstedt, University of Wisconsin.

P6—Essentiality of cobalt in bovine nutrition. W. M. Neal and C. F. Ahmann, University of Florida.

5-MINUTE REST PERIOD

P7—Fermentation energy losses in dairy cattle. L. E. Washburn, University of Missouri.

P8—Acetonemia and ketonuria in dairy cows under farm conditions. C. W. Duncan, C. F. Huffman and H. A. Tobin, Michigan State College.

P9—Certain points in the physiological processes of the cow. R. B. Becker, University of Florida.

P10—The adrenal cortical hormone in relation to lactation. E. T. Gomez and C. W. Turner, University of Missouri.

P11—The rôle of the central nervous system in the hormonal control of lactation. R. P. Reece and C. W. Turner, University of Missouri.

P12—The effect of thyroxine on milk and fat production. H. A. Herman, W. R. Graham and C. W. Turner, University of Missouri.

P13—On the carbohydrate and nitrogen metabolism of the mammary gland. W. R. Graham, University of Missouri.

PRODUCTION SECTION

Thursday morning, June 24, 8 A. M.–12 NOON

Room 303, Dairy Industry Building

F. W. ATKESON, *Chairman*

FEEDING

(Papers limited to 12 minutes)

P14—The value of corn sugar in the grain mixture of dairy calves. Clifton A. Ward, C. Y. Cannon and D. L. Espe, Iowa State College.

P15—Replacing whole milk in the calf ration. R. T. Parkhurst, National Oil Products Co.

P16—Hay consumption of Holstein calves. H. S. Willard, University of Wyoming.

P17—Development of calves on prairie hay when fed milk from dams on similar rations. H. W. Cave, W. H. Riddell and J. S. Hughes, Kansas State College.

P18—Limited prairie hay rations and avitaminosis in dairy heifers. A. H. Kuhlman, Andrew Nalbandov and Earl Weaver, Oklahoma A. & M. College.

P19—Limited grain feeding of dairy cattle. C. E. Wylie and L. R. Neel, University of Tennessee.

P20—Some experiences in feeding cattle on rations devoid of roughage. T. W. Gullickson, University of Minnesota.

5-MINUTE REST PERIOD

P21—A comparison of pasture returns from actual grazing and clip plot methods. I. R. Jones, H. P. Ewalt and J. R. Haag, Oregon State Agricultural College.

P22—The losses of dry matter in corn silage stored in snow-fence silos and the cost per ton of storage. J. B. Shepherd, Bureau of Dairy Industry, U. S. D. A.

P23—The apparent digestibility and feeding value of apple-alfalfa silage. J. C. Knott and R. E. Hodgson, State College of Washington.

P24—Mungbean silage for milk production. A. H. Kuhlman, Andrew Nalbandov and Earl Weaver, Oklahoma A. & M. College.

P25—Molasses grass silage as the sole roughage diet for milk production and growth of dairy animals. C. B. Bender, J. W. Bartlett, H. H. Tucker and J. Mixner, New Jersey Agricultural Experiment Station.

P26—Relation of grass silage to the color, vitamin C and flavor in milk from individual cows. O. F. Garrett, C. B. Bender and H. H. Tucker, New Jersey Agricultural Experiment Station.

PRODUCTION SECTION

Thursday afternoon, June 24, 1 P. M.–4: 15 P. M.

Room 303, Dairy Industry Building

F. W. ATKESON, *Chairman*

VITAMINS

(Papers limited to 12 minutes)

P27—Technique used in studying the vitamin A requirements of dairy cattle. L. A. Moore, Michigan State College.

P28—The carotene and color content of home-grown roughage feeds and the relation of these rations to the carotene, color and vitamin A activity of the butterfat. R. E. Hodgson, J. C. Knott, H. K. Murer and R. R. Graves, Bureau of Dairy Industry, U. S. P. A. and State College of Washington.

P29—Effect of carotene intake on the carotene and vitamin A content of butter. H. J. Smith and E. B. Powell, Ralston Purina Co.

P30—An attempt to remove the vitamin A suppressing factor in soybean oil by adsorbents. S. M. Hauge, J. W. Wilbur and J. H. Hilton, Purdue University.

P31—The relation of A. I. V. alfalfa silage and the carotene content of milk. W. E. Petersen, J. B. Fitch and N. N. Allen, University of Minnesota.

P32—Effect of molasses and A. I. V. silages on the carotene and vitamin A content and growth-promoting quality of milk. D. M. Hegsted and G. Bohstedt in collaboration with C. A. Elvehjem, E. B. Hart, W. H. Peterson and I. W. Rupel, University of Wisconsin.

5-MINUTE REST PERIOD

P33—Oxidized milk flavor as related to carotene, lecithin and vitamin C. C. H. Whitnah, W. H. Martin and G. H. Beck, Kansas State College.

P34—The vitamin D requirement (U. S. P. Units) for growth and well-being of calves from birth to six months of age. S. I. Bechdel, Neal W. Hilston and N. B. Guerrant, Pennsylvania State College.

P35—Studies in methods of concentrating the vitamin D of butterfat for assay purposes. G. C. Wallis, South Dakota State College.

P36—X-ray technique for studying rickets in calves. S. I. Bechdel, Neal W. Hilston, Pennsylvania State College, and Robert F. Light, Fleischmann Laboratories.

P37—Effects of vitamin D deficiency on mature dairy cows. G. C. Wallis, South Dakota State College.

P38—Irradiation of milk; the interrelation of radiation intensity and milk film capacity. H. H. Beck, H. C. Jackson and K. G. Weckel, University of Wisconsin.

PRODUCTION SECTION

Friday morning, June 25, 8 A. M.–10 A. M.

Room 303, Dairy Industry Building

F. W. ATKESON, *Chairman*

Business meeting

GENETICS

(Papers limited to 12 minutes)

P39—Hair pigment. W. E. Petersen and W. M. Sandstrom, University of Minnesota.

P40—The relation of the endocrine glands to the inheritance of milk secretion. C. W. Turner, University of Missouri.

P41—Evaluation of different measures of inherited producing ability in dairy cattle. Gordon E. Dickerson, University of Wisconsin.

P42—Are culls really culls? D. M. Seath, Kansas State College.

P43—Differences between records, real productivity and breeding values of dairy cows. Jay L. Lush and Floyd Arnold, Iowa State College.

ABSTRACTS OF PAPERS PRESENTED AT ANNUAL MEETING

GENERAL SESSION

The Preparation, Properties, and Use of Gonad-Stimulating Hormones.
L. E. CASIDA, Dept. of Genetics, Univ. of Wisconsin.

A general discussion is presented having to do with sources of hormones, method of preparation, and physiological characterization of extracts from different sources. Attention is given to the problems involved in the use of gonad-stimulating hormones in dairy cattle. Variations in extracts and variations in responsiveness of cattle in different reproductive conditions make it difficult to control the end results of hormonal therapy. Emphasis is given to the study and classification of individual cases so that clinical entities may be recognized and their typical response determined.

XI World's Dairy Congress. J. C. MARQUARDT, New York Agricultural Experiment Station.

The Eleventh World's Dairy Congress will be held at Berlin from August 22 to 28, 1937. Like the previous ten Congresses it is sponsored by the International Dairy Federation. These Congresses have confined their place of meeting to continental Europe. One exception was the London Congress. The International Dairy Congress held in 1923 in Washington–Syracuse, U. S. A., was not sponsored by the International Dairy Federation.

It was my pleasure to be in Europe with the leaders of the XI Congress while plans were being formulated. This experience furnished a splendid chance to obtain authentic information on past and present plans for these gatherings. The main function of these meetings has been an attempt to formulate better understandings between scientific workers and the dairy industry of the various countries. Secondary is the opportunity for the host to show to advantage its dairy industry with its numerous appendages plus the country itself.

We are concerned mainly with the plan of the present Congress. It is essential to state that the various countries entertaining the Congress have used widely different means of reaching their objective. The program has ranged from a question box type discussion to the presentation of papers selected to be discussed by the authors. The XI Congress has aimed to have

papers presented so that the presentations fall into definite groups. A limited number of papers falling outside the restricted groups are being planned for by special sessions. It has been reported that 500 papers have been submitted.

It has been my pleasure to review some of the papers offered for presentation at the Congress and also to discuss them with workers on the continent and in Great Britain. From this experience it is my belief that more fundamental and new information will be given out at this than at any previous Congress. The proceedings of the Congress will be available in English, German, and French.

There are tours planned to the dairy sections and also to the dairy research institutes. The research institutes for dairying at Kiel and Weihenstephan have been remodeled and will be completely finished before the opening of the Congress. More than 280 workers are employed at Kiel, and Weihenstephan has a staff of more than 90 persons. In view of the fact that the men at Kiel work in the Dairy field only, the scope of the work is better appreciated by correlating this fact with the number of persons employed.

Trends and shifts in scientific work and technical services in Germany and continental Europe generally will be developments for citizens of our country to study.

An International Dairy Exposition will be held at the time of the Congress. This feature along with the further development of Congress rules, and a more exacting attitude toward a scientific board has greatly strengthened the work of the International Dairy Federation.

W. Clauss, Berlin S.W. 68, Lindenstrasse 28, Germany, is General Secretary of the XI Congress.

The Teacher Interprets Research. W. H. MORTON, Director Teacher Training and Chairman of Department of Secondary Education, Teachers College, University of Nebraska.

The dairy industry today is not suffering so much because of a lack of the right kind of tested scientific knowledge as because of the lack of use or application of such knowledge already known. The research specialist has been at work and the results of his labors are well known to men technically trained in the dairy industry. But a visit to the farms of this country will show that these scientific facts are either not known or at least are not practiced by those who own and operate them.

Here lies the pressing challenge to the leaders of the dairy industry.

1st. Facts, knowledge and skills must be discovered which will improve both the quantity and quality of dairy products. This may belong to research.

2nd. The research worker must next interest himself in helping those engaged in the dairy industry first, to understand the results of the testing

laboratories, and second, and perhaps as important as the first, to want to do something about them. In fact, his task is not done until he sees his tested ideas accepted and universally used.

This act of interpreting scientific knowledge to the uninitiated or layman and stirring within him the inner feeling to do something about it is the task for the teaching process.

It is not enough for scientific men to know the facts; they must be able to reveal them to others and then to inspire action.

To teach well means:

1. To stir up interest to cause a felt need on the part of the learner.

2. To lead him to discover a real problem—to find his progress thwarted.

3. To challenge the inquiring mind to examine the different factors present which may help to solve his difficulty.

4. To challenge the learner to draw tentative conclusions and later to test these conclusions in the field of reality.

5. And last, after having found a satisfactory answer to his problem, to build such attitudes within him that his future action will be changed and old practices will be discontinued and the newer and better way will be followed.

Each act which interprets the storehouse of knowledge in the dairy industry to those who know it not is a teaching act. It follows, therefore, that each member of this association is a teacher and the degree of success of his teaching should be measured by the degree to which the layman makes use of his ideas.

Current practices on the farms of this country show that there is much teaching yet to be done. To many farmers the scientific facts of dairying remain a closed book. There then is a dynamic challenge to teach the facts and inspire action until these bad conditions are eliminated.

Artificial Insemination—Demonstration. H. P. DAVIS AND GEORGE W. TRIMBERGER, University of Nebraska

Artificial insemination has been extensively practiced with horses, but because of the difficulties of obtaining the semen and of keeping the spermatozoa alive under ordinary conditions away from the cow for more than a few hours, it has not been widely used with cattle. Artificial insemination has been used with dairy cattle at this institution for about two years with excellent results. The semen may be obtained by the service of a cow, either one in heat or one that will accept the bull, or by the technique suggested by Miller and Evans.[1] If cows are used it is essential that they have a normal reproductive record and be free from all infections. The method of Miller and Evans[1] is to be preferred since once the technique is mastered it allows

[1] Miller, Fred W., and Evans, E. I., Technique for Obtaining Spermatozoa for Physiological Dairy Studies and Artificial Insemination, Jour. Agr. Res. 34: 941–947.

for a better sample and eliminates the danger of infections from the cow. So far a complete report is possible on 34 cows. These cows were given 62 services and there were 31 conceptions. Two cows had two calves each, and five cows did not conceive. Of the 31 conceptions, 23 were from the first service, 5 from the second, 2 from the third and one from the fourth service. This record covers cows affected with Bang's disease and trichomoniasis. With the improved technique now used, out of 47 manipulations since January 1, 1937, on twelve different bulls, 46 satisfactory samples have been obtained. Care is used in collecting and handling semen to keep it from being contaminated with urine. This is done by emptying the bladder by exerting pressure with the hand through the intestinal wall and then irrigating the sheath with sterile water. A liberal supply of sterile test tubes and several funnels is advisable in order to allow frequent switching of tubes by the assistant to prevent contamination while collecting the sample of semen. A long-handled stick with a clamp for holding the test tube is a great convenience. Best results appear to be possible when metal does not come in contact with the semen. A special 15-inch vaginal speculum, an 18-inch capillary tube attached to a 5 cc. glass syringe, and a flash light provide the other equipment used. The advantages of artificial insemination are:

1. It permits the use of a bull on a large number of cows without injuring his efficiency.

2. It prevents the spread of any infection from cow to cow.

3. It provides for the use of a bull over a much wider geographical area

4. It permits the examination of semen before service.

5. It prevents mechanical difficulties at breeding such as a closed cervix.

6. The size factor in mating is eliminated.

PRODUCTION SECTION

P1. A Study of the Methods of Sampling Milk for Butterfat Tests Where a Combine Milker Is Used. K. S. MORROW AND H. C. MOORE, University of New Hampshire.

Rules for the conduct of official and herd tests adopted by the American Dairy Science Association provide that where combine milkers are used samples may be drawn directly from the glass milk holder. Mixing of the milk for sampling is dependent upon agitation by the inflow of air when the valve at the bottom of the jar is opened. In herds where stripping by hand following the combine milking is practiced, such strippings obviously are not included in the sample taken for testing.

Samples of a few preliminary trials in the University of New Hampshire dairy herd indicated that there were occasionally marked differences in the test of milk drawn directly from the combine milk jar in comparison with

TABLE 1

Variation in butterfat test of samples taken by different methods.
Method No. 1 used as the standard

AMOUNT OF VARIATION	NUMBER OF CASES BY BREEDS									
	Method 1 and 2					Method 1 and 3				
	Ayr.	Guer.	Hol	Jer.	Total	Ayr	Guer.	Hol.	Jer.	Total
% fat										
− 0.10				1	1					
0.00	12	13	36	12	73	3	3	15	2	23
+ 0.05	1	1	3		5	2		1	1	4
0.10	13	7	17	10	47	8	6	18	7	39
0.15			1		1	1	2	2	1	6
0.20	2	3	4	2	11	8	7	19	6	40
0.25				1	1	2	1			3
0.30		2		2	4	4	3	3	4	14
0.40		1	4		5	1	1	4	3	9
0.50			2		2		3	2	3	8
0.60								2	1	3
0.70		1	1		2	1				1
0.80								1		1
0.90									1	1
1.00										
1.10				1	1					
1.20				2	2					
1.30			1		1			1	2	3
1.40			1		1					
1.50									1	1
1.60								1		1
TOTAL	28	27	70	32	157	28	27	70	32	157
NUMBER SHOWING NO CHANGES	12	13	36	12	73	3	3	15	2	23

TABLE 2

Comparative butterfat and solids-not-fat tests of samples taken by different methods

BREED	NO. OF CASES	METHOD NO. 1			NO. 2			NO. 3			VARIATION IN TEST				WEIGHT OF STRIPPINGS
		Milk	Fat	S.N.F.	Milk	Fat	S.N.F.	Milk	Fat	S.N.F.	2 WITH 1		3 WITH 1		
											% fat	% S.N.F.	% fat	% S.N.F.	
		lbs.	%	%	lbs.	%	%	lbs.	%	%					lbs.
AYR.	28	12.25	4.03	9.05	12.25	4.12	9.01	12.67	4.21	9.00	+0.09	-0.04	+0.18	-0.05	0.41
GUER.	27	11.51	5.12	9.20	11.51	5.21	9.18	11.86	5.33	9.17	+0.09	-0.02	+0.21	-0.03	0.34
HOL.	70	20.29	3.29	8.17	20.29	3.41	8.16	20.80	3.49	8.16	+0.12	-0.01	+0.20	-0.01	0.46
JER.	32	9.84	5.09	9.36	9.84	5.28	9.35	10.28	5.45	9.31	+0.19	-0.01	+0.36	-0.05	0.44
AVE.	157	15.22	4.10	8.75	15.22	4.23	8.73	15.65	4.33	8.72	+0.13	-0.02	+0.23	-0.03	0.43

the milk when sampled after being drawn into a separate container and thoroughly mixed. Since the average daily production of the cows was almost twice that of animals reported in a similar trial by Missouri in 1933, and with a larger proportion of strippings than they reported, it was deemed advisable to make a comparison of the methods of sampling from the combine milker in the University herd.

Methods used were: Method No. 1—sample taken directly from glass jar; Method No. 2—sample taken from milk after being drawn from jar and thoroughly mixed; Method No. 3—sample taken after thorough mixing of combine milk with hand strippings added. The butterfat was determined by the Babcock test. Total solids also were run on each sample by the Mojonnier test, the solids-not-fat determination serving as a check on the accuracy of the fat test.

Table 1 shows a distribution of the variation in test of 157 samples. For the entire group 46.5 per cent of the samples by Method No. 2 showed no change in comparison with samples taken directly from the jar. In only one case was the test lower by the No. 2 method. When the strippings were added to the milk before sampling, the test was increased in 85.4 per cent of the samples.

The comparative butterfat and solids-not-fat tests and the amounts of milk produced are given in Table 2. Both tables indicate a breed difference in the variation between the three methods of sampling for butterfat test under the conditions of the trial. The thorough mixing of the sample in contrast to taking directly from the jar increased the fat test in 52.8 per cent of the cases. This increase is not significant and substantiates the findings of previous investigation. The very slight variation in solids-not-fat test for the three methods substantiates the accuracy of the butterfat test obtained on the samples. For the determination of solids-not-fat either method gave reliable analysis. The value of including the strippings before sampling is still a debatable one. Using the tests as listed in Table 2, the fat production credits of the individual cows in the University of New Hampshire herd in 1935–36 would have been increased as follows if Method No. 3 had been used in place of Method No. 1—Ayrshires 10.8 lbs. Guernseys 11.4 lbs., Holsteins 22.5 lbs., Jerseys 25.2 lbs.

P2. Changes Occurring in Freshening Dates from Year to Year of Cows in Iowa Testing Associations. C. Y. CANNON AND D. L. ESPE, Iowa State College.

Previous studies of data from testing associations of the United States show that cows which freshen in the fall produce a higher average yield of milk than cows which freshen in other seasons of the year. This has been publicized widely through extension agencies and should have influenced dairy farmers to breed their cows for fall freshening. If such a shift in

freshening dates occurred it should be shown in the records of the cow testing associations.

The available records of the Iowa Cow Testing Associations covering ten years (1926–1935 inclusive) disclosed a total of 131,135 cows with known calving dates. When these were sorted by months and by years in which the freshening occurred they showed that very little change occurred in the percentages of cows that freshened each month from year to year. During the ten years the calving distribution seems to have shifted slightly from the winter and spring to the summer and fall seasons though in 1935 the shift was in the opposite direction. Samples of these data show no significant relation between age of cow and time of calving. An estimated calving interval of approximately 454 days for all cows in the cow testing associations during the ten years indicates that apparent shifts in calving time which occurred are probably the result of factors not entirely under the control of the dairymen.

P3. A New Visible System of Dairy Herd Books. F. W. ATKESON AND H. W. CAVE, Kansas Agricultural Experiment Station.

After study of many types of forms for keeping dairy herd records, new forms and a visible type of binding has been evolved. The forms are smaller (7 5/8″ × 14″) than most herd books and yet are more complete. An effort was made to prepare forms that not only present the usual data on production and reproduction, but in addition complete records on breeding, breeding efficiency, disease history, and treatment.

The record system consists of four sheets of two forms each (front and back). Title of each sheet implies its use; individual cow record, continuous sire record, yearly herd summary, and annual herd inventory. Each form is so prepared that a summary of the most essential data is presented at the bottom of the sheet and the binding system exposes this bottom edge of each sheet.

This system represents the loose leaf system of binding making possible the keeping of the active herd in the visible type binder and the animals removed from the herd in another binder.

Some of the advantages of the system suggested are: all essential information is presented in tabular form on all animals in the herd; no index is needed; the animals may be arranged in convenient groups such as open cows, pregnant cows, heifers of breeding age, and heifers less than breeding age; these groups can be arranged in order of breeding dates, freshening dates, etc.; a ready inventory is presented of the number of cows bred to certain bulls, number of daughters of certain bulls, etc.

Two types of binders are suggested, the "Shif-Dex" for large herds and a special ring binder for smaller herds.

P4. Estimating Live Weight from Chest Girth of Dairy Cattle of Unknown Age.* S. Brody, H. P. Davis and A. C. Ragsdale, Missouri and Nebraska Agricultural Experiment Stations.

The size of an animal may be interpreted in relation to the parts which make up the body as a whole, and in relation to age. This statement of organic interrelatedness practically constitutes what may be termed the "field" theory of growth, structure, and function. Many years ago C. H. Eckles, at the Missouri Station, initiated an investigation on growth of dairy cattle apparently with the idea of ultimately interpreting the interrelatedness of 21 linear measurements, weight, age, feed supply, etc. Eckles' successors at the Missouri Station made many attempts to integrate his growth data by a "unified field theory." (See, among others, Missouri Agric. Expt. Station Res. Buls. 67, 1924; 80, 1925; 103, 1927.) It was demonstrated (Res. Bul. 103) that the interrelations between practically every one of the 21 Eckles measurements and body weight follow a constant pattern or design, and that this pattern can be formally represented by the equation $Y = bX^n$ in which Y is the magnitude of a given measurement and X is the weight of the body. The concrete meaning of the applicability of this equation to the data is simple: thus if n in the equation is 2, then the *percentage* increase in Y is 2 times as great as the *percentage* increase in X.

This field equation, which apparently represents the basic pattern of development of form, was first applied to the prediction of weight from linear size in work at the Missouri Station (Missouri Expt. Sta. Res. Bulletins 141, 1930, and 142, 1930); later it was embodied in a formal prediction table (Ragsdale and Brody. Estimating live weight of dairy cattle, Missouri Station Bulletin 354, 1935). At roughly the same time a similar prediction table was derived independently by an arbitrary procedure (tracing free-hand a curve through weight-chest girth data) by Kendrick and Parker (Estimating the weight of dairy cows from heart-girth measurements. U. S. Dept. Agr., Bureau of Dairy Industry, B. D. I.—695, 1936). In the present paper we introduce what we shall call the "Missouri-Nebraska Standard" for estimating live weight from chest girth. This "standard," generalized by the above "field" equation, is based on 15,610 sets of chest girth-weight measurements. Of these, 10,921 sets were secured under the direction of H. P. Davis (Nebraska) and 4689 under the direction of A. C. Ragsdale (Missouri).

Data on which the present paper is based are presented with the aid of charts indicating the nature and utility of the proposed standard. One of these charts, presented herewith, shows that the *formal relation* between weight, W, and the chest girth, G, is $W = bG^n$; and that the *numerical value*

BODY WEIGHT — M IN KGS.

BODY WEIGHT — M IN LBS.

CHEST GIRTH — G IN CMS.

CHEST GIRTH — G IN INS.

STANDARD ERROR OF ESTIMATE

$+S_R = 13.3\%$
$-S_R = 11.7\%$

ALL DATA (15,640 SETS OF MEASUREMENTS)

HOLSTEIN, NEBR. ①
HOLSTEIN, MO. ②
JERSEY, NEBR. ③
JERSEY, MO. ④
AYRSHIRE, NEBR. ⑤
GUERNSEY, NEBR. ⑥

BREED	LBS-INS.	KGS-CMS.	$+S_R$	$-S_R$	P
HOLSTEIN, MO.	$M=0.0036\,G^{2.84}$	$M=0.00018\,G^{2.84}$	10.1%	9.2%	0.9841
HOLSTEIN, NEBR.	$M=0.0082\,G^{2.75}$	$M=0.00029\,G^{2.75}$	15.5%	14.4%	0.9817
JERSEY, MO.	$M=0.0049\,G^{2.88}$	$M=0.00016\,G^{2.88}$	13.2%	11.7%	0.9788
JERSEY, NEBR.	$M=0.0058\,G^{2.83}$	$M=0.00019\,G^{2.83}$	10.3%	9.1%	0.9827
GUERNSEY, NEBR.	$M=0.0041\,G^{2.91}$	$M=0.00013\,G^{2.91}$	13.0%	11.5%	0.9894
AYRSHIRE, NEBR.	$M=0.0046\,G^{2.88}$	$M=0.00014\,G^{2.88}$	11.2%	10.5%	0.9901
ALL DATA	$M=0.0060\,G^{2.82}$	$M=0.00020\,G^{2.82}$	13.3%	11.7%	0.9746
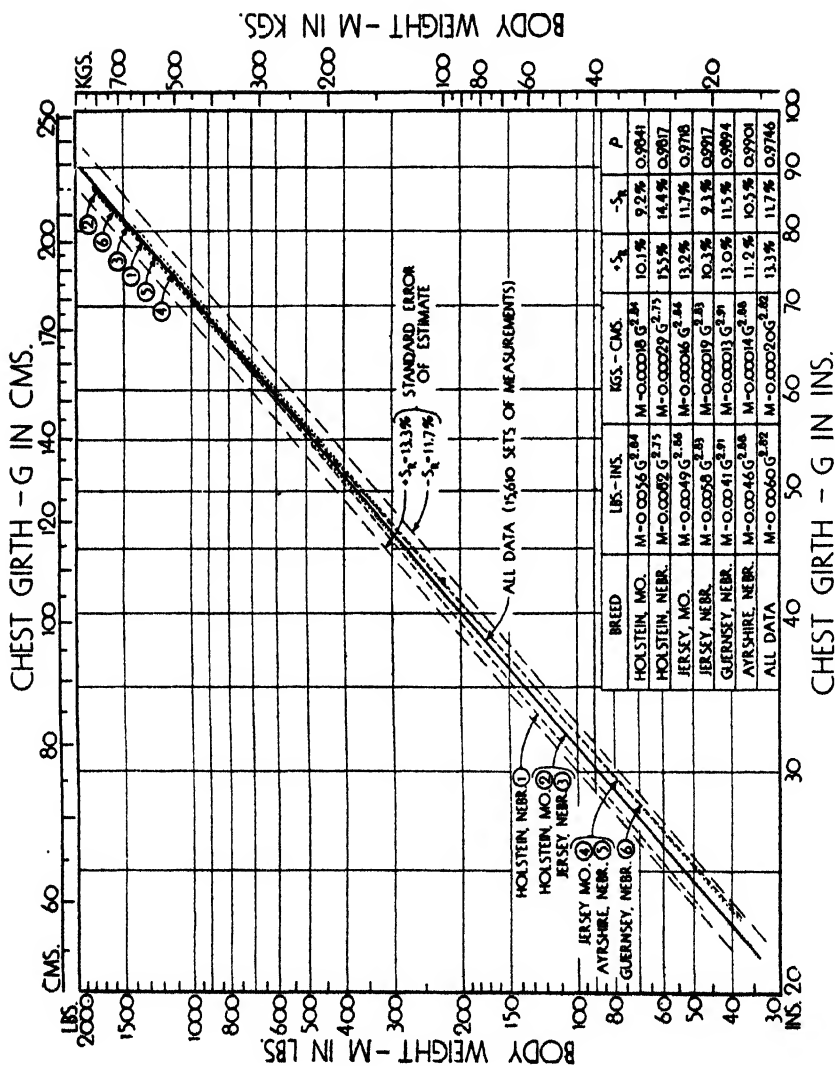
of *n* in 2.82, of the standard error of estimate of all the 15,160 sets of measurements and the equation is + 13.3% and − 11.7%, and of the index of correlation is 0.9746. The meaning of 2.82 is that the *percentage* increase in weight is 2.82 times as rapid as the *percentage* increase in chest girth; of + 13.3 and − 11.7, is that 2/3 of all the 15,610 sets of measurements are within + 13.3% and − 11.7% of the computed average curve.

P5. Is the Calcium: Phosphorus Ratio of Common Mineral Mixtures Suited to Dairy Cattle? G. BOHSTEDT, University of Wisconsin.

Most mineral mixtures used for dairy cattle in north central states have a greater excess of calcuim over phosphorus than is physiologically correct. A common relationship of these two elements in both home-mixed and commercial mineral mixtures is the presence of 4 to 8 parts of calcium for every 1 part phosphorus, by weight. This means that such mixtures contain fully as much, frequently two to three times as much, ground limestone as bone meal, or minerals equivalent to these two typical mineral feeds. It is suggested that this relationship is an illogical one for dairy cattle that, if in need of additional minerals at all, are primarily in need of phosphorus rather than calcium. The frequent occurrences of pica or phosphorus deficiency diseases of cattle in various countries are abundant proof of this. On the other hand there are no widespread corresponding occurrences of calcium deficiencies in cattle, and recent work at Minnesota has shown that dairy cattle may grow, reproduce, and produce milk successfully on rations that are low in calcium. While it is recognized that the need of dairy cattle for calcium must be met, this element in practical rations is not apt to be as critical an element as is phosphorus.

It has been demonstrated by U. S. D. A. workers that a favorable Ca : P ratio in dairy cattle rations is less than 2 parts calcium for every 1 part phosphorus, by weight. In case of a phosphorus deficiency, it is obviously impossible to correct it and still have the ration remain at or below the 2Ca : 1P ratio by feeding mineral mixtures that have from 4 to 8 parts calcium to every 1 part phosphorus. That this is what dairymen are doing, or are asked to do, is proved by the situation in Wisconsin which is also typical for neighboring states. For the year 1937 there are 47 mineral manufacturers in Wisconsin and 5 other states who have registered their products with the State Department of Agriculture and Markets. Of the 47 firms, 4 have as their entire output non-phosphate minerals, or therefore primarily limestone and oyster shells. One firm produces dicalcium phosphate. Six have mineral mixtures for cattle which mixtures on the basis of their guarantee have a calcium : phosphorus ratio averaging 2.7 : 1, and varying from 2.0 : 1 to 3.4 : 1. But the remaining 36 firms, or therefore the vast majority, prepare and sell cattle mineral mixtures with a calcium : phosphorus ratio averaging 5.9 : 1, with a range of 4.1 : 1 to 11.3 : 1. Thus even the lower ratio represents

mixtures having as much as 1 part high calcium limestone to 1 part steamed bone meal.

It is pointed out that wheat bran, linseed meal, cottonseed meal or similar protein concentrates in dairy rations in large part take care of the need for phosphorus. If the use of such feeds is not called for in practical rations and if the roughage has been grown on phosphorus-poor soil, it may be advisable to use a suitable grade of bone meal, bone black, rock phosphate (with fluorine removed), or other phosphates having 1 part or more phosphorus for every 2 parts calcium.

P6. The Essentiality of Cobalt in Bovine Nutrition. W. M. NEAL AND C. F. AHMANN, Florida Agricultural Experiment Station.

A condition of malnutrition has been encountered in controlled feeding trials with calves on a ration of Natal grass (*Tricholena rosea*) hay, shelled corn and dried skimmilk that may be prevented or overcome by the use of a cobalt supplement. None of these feeds showed the presence of cobalt upon spectrographic examination. This deficiency occurs on certain soil types (not all determined) and may or may not overlap a nutritional anemia that responds to iron and copper supplement. However, in the experiments to be reported, the use of ferric ammonium citrate and copper sulfate aggravates the condition unless cobalt is administered also.

Affected animals show a long and rough hair coat, scaliness of the skin, listlessness, retarded development of sexual characteristics, gauntness due to loss of appetite, and muscular atrophy. The erythrocyte count may be above average, and the hemoglobin concentration equal to or above that in animals receiving cobalt and making normal growth. The amount of hemoglobin per erythrocyte, or per volume of erythrocytes, is reduced. The condition would be classed as a *microcytic hypochromic anemia*. The spleen is shriveled and fibrous and the heart of normal size but very flabby.

No polycythemia has been encountered at the rates (5.0–10.0 mgs. per animal per day) at which cobalt has been given.

Examples of growth rates are shown in Figure 1. E-79, receiving 5 mgs. cobalt per day, made uniform gains until he weighed over 550 pounds. Irregularities in his growth curve, and that of E-74 at the higher weights may be attributed to a marginal cobalt intake, or to an additional undetermined deficinecy. That cobalt intake may have been marginal is shown by the increased growth of E-86 when the cobalt intake was increased. E-86, receiving cobalt, weighed 85 pounds more than E-85 on the check ration at 14 months of age, and the differences in physical appearance were even more striking. The retarded growth, due to the use of ferric ammonium citrate and copper sulfate, is shown in the curves for E-74, E-87, E-78 and E-73. No animal has been raised to a weight of over 450 pounds on this ration of Natal grass hay, shelled corn and dried skimmilk without the use of a cobalt supplement.
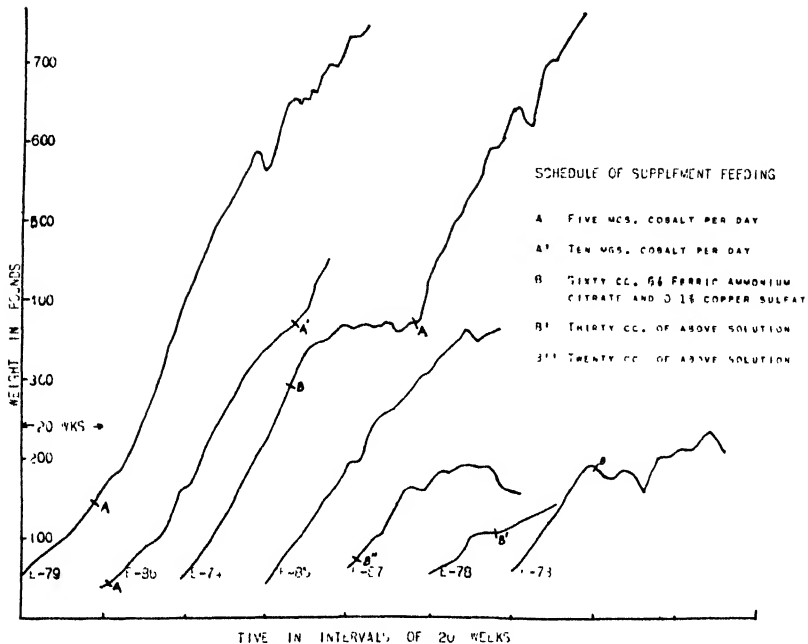
FIG. 1. Growth of calves showing the effect of cobalt, and iron and copper supplements, with a ration of Natal grass hay, shelled corn and dried skimmilk, the hay and corn being produced on deficient land.

P7. Fermentation Energy Losses in Dairy Cattle.* L. E. WASHBURN, Missouri Agricultural Experiment Station.

Rumen and expired gases of a dairy cow were measured simultaneously at different times after feeding. The results indicate that, contrary to the commonly accepted opinion, the ratio between fermentation carbon dioxide and combustible gases is subject to a considerable but characteristic variation. Expired fermentation carbon dioxide computed from the above ratio and uncorrected for salivary carbon dioxide not only necessitated a reduction in the respiratory quotient (0.007 to 0.465—depending on feed and time after feeding), but also represented a carbon loss equivalent to 835–1749 Calories in a 24-hour period. Total energy losses in fermentation carbon dioxide and combustible gases were calculated to amount to 12 to 16 per cent of the feed energy intake, or 25 to 40 per cent of the maintenance requirement. Rumen oxygen and nitrogen values showed that aerobic influence is undoubtedly present, though not appreciable. As digestion proceeded, the rumen gases tended to approach values comparable to intestinal gases.

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P8.　Acetonemia and Ketonuria in Dairy Cows under Farm Conditions.
C. W. DUNCAN, C. F. HUFFMAN AND H. A. TOBIN, Michigan Agricultural Experiment Station.

This report is based upon a study of some of the constituents in the blood and urine of a herd of purebred Jersey cows, all of which were suffering from acetonemia.　The ration consisted principally of poor quality soy bean hay, grain mixture and corn silage.

All of the cows had calved normally within two to six weeks of the onset of the disease.　The milk yield soon dropped markedly, the cows lost their appetite and have taken on a haggard appearance.

The average value for ''acetone bodies'' in the blood of the eight cows before treatment was 25.8 mg per 100 cc., the limits of variation being 2 64 mg. to 79.05 mg.　At the end of the three weeks these same values had dropped to 2.87, 0.93 and 6.20 mg. respectively.

The average value for ''acetone bodies'' in the urine, collected at the same time as the blood, was 167.4 mg. per 100 cc., the limits of variation being 20.3 mg. to 549.5 mg.　These same values dropped to 41.1, 14 4 and 76.2 mg. respectively, within three weeks from the time of treatment.

Milk samples from five of the most severely affected cows also contained ''acetone bodies'' varying from 5.0 mg. to 42.9 mg. per 100 cc. of milk.

The carbon dioxide combining capacity of the blood plasma increased to a slight extent during the treatment (58.0 vol. to 62.2 vol. per cent, mean values).　A marked reduction in the carbon dioxide combining capacity of the blood plasma during severe acetonemia was not observed.

The data that we have thus far accumulated indicate that the qualitative test for ''acetone bodies'' in the urine is applicable only to the detection of these substances in the urine and gives little indication as to the presence or absence of ''acetonemia.''　These data also indicate that cows under the conditions of this experiment may have abnormal amounts of ''acetone bodies'' in the urine but normal amounts in the blood.

P9.　Certain Points in the Physiological Processes of the Cow.　R. B. BECKER, Florida Agricultural Experiment Station.

A.　The Omasum as a Grinding Organ.　The fineness of feed particles in the several compartments of the cow's digestive system has been determined, using six Jersey and Guernsey cows on sole diets of corn silage, No. 2 alfalfa hay, alfalfa meal and Bermuda grass pasture.　After slaughter, the contents of each organ were sampled, dried at low temperature, and separated by sieves into the sizes of particles, which were weighed.

Even a 16-year-old cow ground corn silage finely.　Feed particles mainly exceeded 5 mm. in diameter in the 1st and 2nd stomach compartments, while 51 to 69 per cent by weight was under 1 mm. in diameter in the 3rd com-

partment (omasum) and beyond. The same was true of a second mature cow fed corn silage.

With No. 2 alfalfa hay (uncut), 64 to 75 per cent of the material in the third compartment and beyond, was less than 1 mm. in diameter, while anteriorly to this compartment, 57 to 69 per cent exceeded this size.

When No. 2 alfalfa hay was passed through a hammer mill to the point that only 1.09 per cent exceeded 1 mm. in diameter, it appeared that either the coarser portions delayed in passage, or the ground material swelled, and did not shrink on drying. This observation was after a 22-day preliminary feeding period with one cow.

One cow received Bermuda grass on pasture for 10 days prior to slaughter. Few feed particles in the 1st and 2nd stomach compartments exceeded 3 mm. in diameter. From the 3rd compartment onward, less than 6 per cent of the particles exceeded 1 mm. in diameter.

The third compartment of the stomach of each cow was severed into an anterior and posterior portion prior to taking the samples. In 5 out of 6 cases, the increased weight of small particles in the posterior portion suggested actual trituration or grinding in this organ. Little difference was seen in the sixth case.

This work, done between January and November in 1929, agrees with the conclusions of Trautmann and Schmitt in 1935. They short-circuited the omasum surgically in young goats, and found that feed particles were much coarser in the abomasums of operated goats than in normal animals of the same age. The 3rd compartment of the ruminant stomach is a grinding organ, and contributes to mechanical digestion of roughages.

B. Flow of Venous Blood from the Udder. Reference books state, and have been quoted, that venous blood leaves the udder through three pairs of efferent veins: the anterior, middle and posterior mammary veins, more commonly called subcutaneous abdominal, external pudic and internal pudic veins. These include Sisson's "Anatomy of domestic animals," Grimmer's "Lehrbuch der Chemie und Physiologie," Monvoisin's "Le Lait, physiologie, analyse, utilisation," and Missouri station bulletin 344 which cited Glattli.

On the other hand, Fuerstenberg, Plumb, Bitting, and Ernst, Mohler and Eichhorn (Textbook of milk hygiene) mention only two pairs of efferent veins from the udder. Sven Wall of Sweden showed the same in an illustration borrowed from the French veterinary text by Moussu in 1902.

In 1920, a group of graduate students under Prof. A. C. McCandlish failed to demonstrate three pairs of efferent veins in the udder taken from a heifer. Contrary to the text, valves were found in the internal pudic vein which would prevent outflow from the udder. Curiosity was aroused which discussion and reading did not satisfy.

Since 1923, 10 udders have been dissected at the Kansas, Oklahoma and Florida stations. Seven of these observed closely showed flow in the internal

pudic vein to be *into* the mammary venous plexus, rather than *away* from it. This means that the posterior mammary, or internal pudic, vein can no longer be regarded as an efferent vein draining the udder.

Other observations are that sometimes there may be a double anastamosis of the mammary veins in the rear of the udder. A variable number of valves occur in the mammary venous plexus which divide the direction of venous flow between the subcutaneous abdominal veins anteriorly, and the external pudic or middle mammary veins, upward from the rear quarters of the udder.

P10.   The Adrenal Cortical Hormone in Relation to Lactation.*   E. T. Gomez and C. W. Turner, Dairy Husbandry Dept., Missouri Agricultural Station.

Hypophysectomy of lactating laboratory and domestic mammals is followed by a rapid cessation of lactation. The injection of the purified preparation of the lactogenic hormone, galactin, immediately after hypophysectomy or after the complete cessation of lactation following the operation was found to be incapable of reinitiating or preventing the rapid cessation of lactation, the animals being dry in 2 to 3 days after the complete removal of the pituitary gland. However, when crude pituitary extracts were employed, milk secretion corresponding to that observed in normal lactating animals was maintained. These observations were taken to indicate that certain other pituitary principles either directly or indirectly through the endocrine glands controlled by them, supplement the effects of the lactogenic hormone in stimulating the secretion of milk. Experiments were, therefore, initiated in order to determine what other pituitary principles play a direct or indirect role in lactation. As it is well established that the thyroid and the adrenal (cortex) glands atrophy following hypophysectomy, our attention was turned to the hormones of these glands. In this report, however, only the role of the adrenal cortex in lactation will be considered.

The spontaneous hypoglycemic coma which develops in hypophysectomized guinea-pigs was successfully controlled to a great extent by the daily administration of glucose solution. In the experiments to be described it should be recognized that this solution played an important role in maintaining the level of blood glucose which is an important precursor of milk.

The injection of adrenal cortical extracts (eschatin) or the purified pituitary adrenotropic hormone which influences the activity of the adrenal cortex immediately after hypophysectomy of lactating guinea-pigs were incapable of supporting the continuance of the secretion of milk. However, when galactin was injected simultaneously with either eschatin or the adrenotropic hormone, the rapid cessation of milk secretion which follow hypo-

physectomy was prevented and by continued treatment, lactation corresponding to that observed in normal parturient guinea-pigs was maintained.

These observations are believed to indicate that the reason for the cessation of lactation following hypophysectomy in the guinea-pig is due to the withdrawal of the lactogenic, the adrenotropic and probably the carbohydrate metabolism hormone of the pituitary. The adrenotropic hormone stimulates the production of a hormone or hormones by the adrenal cortex which in turn influences the salt and fluid metabolism. In adrenal insufficiency induced by hypophysectomy there occurs a rapid shifting of fluids and salts (NaCl) from the tissue and intercell spaces into the blood stream. The resulting polyurea after hypophysectomy and the associated increased excretion of salt causes a gradual withdrawal of fluid and consequently a dehydration of the tissues. As a result the passage of the precursors of milk from the blood stream to the mammary tissue is prevented, thereby depressing the secretary function of the lobule cells.

P11. The Rôle of the Nervous System in the Hormonal Control of Lactation.* R. P. REECE AND C. W. TURNER, Missouri Agricultural Experiment Station.

The influence of the nervous system on the functional control of the mammary gland appears to be a neglected field of physiological research. In the early investigations of Roehrig, where he sectioned the nerves leading to the udder, it is difficult to determine whether he was studying the influence of the nerves on milk secretion or on milk removal. If the nerves leading to the udder play any part in the control of mammary activity it is probably by their regulation of the vascular system. More recently, Selye *et al.* have shown that the act of suckling prevented the involution of the mammary gland of the rat during a period of 14 days, even though the milk ducts were ligated.

With the development of a technique for the determination of minute quantities of galactin in the pituitaries of laboratory animals it became of interest to determine the influence of suckling upon the galactin content of the pituitary gland.

Rats were allowed to nurse their young for 36 hours after delivery. The young were then removed for a period of 12 hours, receiving no nourishment during this period, and then returned to their mothers for a three hour nursing period. The mother rats were then sacrificed, their pituitaries removed and assayed. For controls the same procedure was employed except that the litters were not returned to their mothers. The pituitary glands from the suckled rats contained about one-third as much galactin as those from unsuckled rats.

The question then arose as to whether the decrease in the galactin content of the rat pituitary under the influence of suckling was due to the stimulus of suckling or to the removal of milk from the mammary glands. By ligating the milk duct of each mammary gland in a series of lactating rats and then subjecting them to a nursing period of three hours it was possible to definitely decrease the galactin content of the pituitary glands.

P12.   **The Effects of Thyroxine on Milk and Fat Production.***   H. A. HERMAN, W. R. GRAHAM AND C. W. TURNER, Dairy Husbandry Department, Missouri Agricultural Experiment Station.

It has been previously demonstrated that the injection of thyroxine in cows in the declining phase of lactation will increase milk secretion.

In view of these findings which are confined to only a few observations, it was decided to investigate this problem further, particularly because of its striking significance in the endocrine control of milk secretion. Cows in the various stages of lactation were selected for this project so as to demonstrate the effects of thyroxine on cows at the peak of their production, in the early declining phase, and also at the approximate end of lactation. Inasmuch as thyroxine raises the metabolism level, feed consumption has been carefully checked and the weight of the cows obtained weekly.

The project is divided into two phases: (a) the feeding of desiccated thyroid at levels of 2 ounces daily, and (b) the injection of thyroxine daily in doses of 5 to 10 mg.

In the thyroxine feeding 6 cows at the peak or just past the peak of production were used. Two cows at the peak of production showed little response in the way of an increase in milk and fat production, but for 9 weeks maintained a consistently high level of production (about 50–55 pounds daily) and immediately dropped to an average of 42 pounds per day when the thyroxine feeding was discontinued. Four cows just past the peak of production showed increases in daily milk production of 16 to 30 per cent. The production declined rapidly when thyroid feeding was discontinued for a 4 weeks period. Resumption of feeding, however, demonstrated a rapid rise in daily production even though most of the cows were in the 25th to 30th week of lactation. In one case the increase amounted to 344.5 per cent, but averaged approximately 20 per cent for all animals in the group.

The injection of 5 mg. thyroxine daily in four cows was noted to give increases in daily milk production of approximately 15 per cent when the cows were just past the peak of production. After three weeks, injection was discontinued, and then resumed after the cows had been in lactation from 160 to 180 days. In the second period of injection 10 mg. of thyroxine was being injected daily. This phase of the experiment is not complete but

during the first week of injection, increases of 10 to 20 per cent in daily milk production, with a marked rise in fat percentage, was evident.

The percentage of fat in the milk produced was increased by both thyroid feeding and thyroxine injection. The solids-not-fat are apparently slightly increased during the periods of injection or feeding.

Three cows injected with thyroxine (10 mg. daily for 2 weeks) at the peak of their production have shown a rapid decline in daily production.

There was no marked change in the weight of the cows during the phases of thyroid feeding or thyroxine injection completed thus far.

P13. On the Carbohydrate and Nitrogen Metabolism of the Mammary Gland. W. R. GRAHAM, Dairy Husbandry Department, Missouri Agricultural Experiment Station.

Studies of the arterial venous differences for levels of constituents in the bloods of lactating goats together with blood volume flow measurements indicated that our knowledge of the nature of the precursors of milk is incomplete.

Experimental results are presented to show that the carbohydrate milk precursor fraction must be enlarged to include lactic acid and carbohydrate formed from protein decomposition. The respiratory quotients of the mammary gland indicate fat formation from carbohydrate.

The values for urea nitrogen found in the bloods show that the nature of the precursors of milk protein must be revised. The loss of nitrogen as urea by the mammary gland often exceeds the uptake of amino N as indicated by the same samples of blood.

The production of urea nitrogen by the mammary gland suggests a new avenue of thought regarding the possible mechanisms of the stimulation of milk secretion by high protein feeding.

P14. The Value of Corn Sugar in the Grain Mixture of Dairy Calves. CLIFTON A. WARD, C. Y. CANNON AND D. L. ESPE, Iowa State College.

Three groups of calves were fed from 10 days to 6 months of age. Group I was fed a standard grain mixture, while Groups II and III received a similar ration except that corn sugar replaced 10 and 20 per cent respectively of the grain mixture. The nutritive ratio of the grain mixtures fed the calves in Groups II and III was held constant by replacing a necessary amount of the corn with corn gluten meal.

Each of the three groups of calves made excellent gains. At 6 months of age the calves fed the 20 per cent corn sugar grain mixture were 24 pounds heavier, and two centimeters higher at withers than the calves in the check group, but when the data were treated statistically there were no significant differences in weight or in body measurement.

The corn sugar apparently increased the palatability of the grain mixture as the calves in Groups II and III started eating the grain earlier than the calves in Group I. The calves fed the 20 per cent corn sugar ration also consumed slightly more grain during the earlier part of the experiment when the grain was fed ad libitum.

P15. Replacing Whole Milk in the Calf Ration. R. T. PARKHURST, National Oil Products Company, Harrison, New Jersey.

Results of investigations reported before this Association by the U. S. Bureau of Dairy Industry and investigators in several experiment stations have shown that good results have been obtained by never letting the calf suck the dam and, after three days on colostrum, replacing the whole milk in the calf ration with only skimmilk, grain, hay, and a Vitamin A supplement.

On the basis of previous experimental work, the following method to replace whole milk and the sucking of the dam by the calf, has been recommended. The colostrum is fed in a bucket for four days. From the fifth day, one teaspoonful of vitamin A and D concentrate in cod liver oil (concentrated cod liver oil, fortified cod liver oil, cod liver oil fortified in vitamin A and D) is added daily per calf to separated or reconstituted skimmilk made by adding one part of dry skimmilk to nine parts of warm water. At three weeks, and until milk feeding is discontinued, the vitamin supplement is added at the rate of two teaspoonfuls per calf per day. As soon as the calf begins eating grain, calf meal containing the vitamin concentrate is kept in front of the calf at all times. Otherwise, three teaspoonfuls of the vitamin-carrying oil is fed per day.

Extensive field demonstrations covering a wide variety of conditions have shown that under field conditions it is often possible to successfully replace whole milk in the calf ration.

P16. Hay Consumption of Holstein Calves. H. S. WILLARD, University of Wyoming.

The Wyoming Experiment Station has become interested in investigating the factors influencing the consumption of roughage by dairy calves. The need of data became evident when a review of literature revealed a wide variation in the amount of roughage reported as consumed.

One group of eight registered Holstein heifer calves, hereafter called Group 1, were fed according to the average of the Morrison feeding standard. The calves were fed in individual box stalls from birth to 12 months of age. Whole milk was fed until the calves were about 3 months of age during which interval the grain mixture was fed ad libitum. Thereafter the grain allowance depended upon the consumption of hay but never got below 2 pounds daily. The calves were never allowed to go on pasture but had

access to a dry lot for about 5 hours during the day. Daily weights were taken on all calves. The hay and grain were weighed out to the calves daily and all refused feeds weighed back.

The grain mixture consisted of 3 parts ground barley, 2 parts ground oats, and 1 part wheat bran. One per cent common salt was added to this mixture. Long alfalfa hay was fed as a sole roughage. For the most part the alfalfa was of high quality ranging between 16 to 18 per cent crude protein. Oat and wheat straw was used for bedding. The calves had access to water in the dry lot and to drinking cups in the barn.

Another group of 8 registered Holstein heifer calves, hereafter known as Group 2, were fed in a manner similar to those in Group 1 until they were about 8 months of age. At that time the grain allowance was gradually decreased and the hay allowance increased until the calves were on hay alone at an average age of 10 months.

From birth to 6 months of age Group 1 consumed 34 pounds more hay, 95 pounds more grain but 188 pounds less milk per calf than Group 2. From 6 to 12 months age Group 1 consumed 248 pounds less hay and 149 pounds more grain per calf than Group 2. For the first 6 months between 10 to 12 per cent of the hay allowance was refused in both groups. During the second 6 months Group 1 refused 12 per cent and Group 2, 6 per cent of the hay offered. Even with a greater amount of hay fed to Group 2 there was a smaller percentage refused which indicated that the grain fed to Group 1 had a depressing effect on the hay consumption. Considering the hay and grain consumption of all 16 calves individually there was a trend toward greater hay consumption with a decreasing allowance of grain. The average daily hay consumption for Groups 1 and 2 when the calves were 8, 10 and 12 months of age was as follows:

	Age in months		
	8	10	12
	Average daily hay consumption (pounds)		
Group 1	8.7	11.6	13.1
Group 2	9.0	13.2	18.8

The rate of growth of both groups of calves was very similar and compared favorably with the average of experiment station data published in the 20th edition of Morrison's Feeds and Feeding.

The experiment shows the possibility of securing satisfactory growth by feeding calves on alfalfa hay alone beginning at 10 months of age.

P17. Development of Calves on Prairie Hay When Fed Milk from Dams on Similar Rations. H. W. CAVE, W. H. RIDDELL AND J. S. HUGHES, Kansas Agricultural Experiment Station.

From a prairie hay investigation there were available two groups of cows which had received only prairie hay and a concentrate mixture low in caro-

tene after six months of age. A third group fed the same except for the addition of Atlas sorgo silage was also available. It seemed desirable to further measure the nutritive value of prairie hay with calves from cows fed the same hay, a low carotene grain mixture and whole milk and skimmilk from their mothers.

Eight calves divided into two groups of four each were used in this trial, and were fed through a six months period. They were the first calves from the cows mentioned above. All of the dams of calves in Group I and two of Group II calves received prairie hay only as the roughage. Two of the Group II calves were from dams receiving silage in addition to prairie hay. The grain mixture fed all the dams consisted of equal parts of white corn chop, wheat bran and cottonseed meal.

All the calves received prairie hay ad libitum and a grain mixture consisting of equal parts of white corn chop and wheat bran, The hay fed to the dams and also to these calves were graded approximately No. 2 upland prairie. The grain allowance per calf at no time exceeded three pounds daily. For three days after birth each calf was fed its mother's milk. Thereafter, until two weeks of age, each calf in Group I received ten pounds of mixed milk from cows receiving only prairie hay as roughness. After the second week these calves were gradually changed to skimmilk separated from the milk of the same group of cows. Group II was handled in the same manner except that the whole milk and the skimmilk fed came from cows receiving a roughage ration consisting of prairie hay and Atlas sorgo silage. Calves in both groups were limited to twelve pounds of skimmilk daily.

The amounts of nutrients consumed by Groups I and II were approximately the same. For the purpose of another investigation these calves were the result of mixing breeds, a purebred Ayrshire bull mated to high grade Holstein cows. This mixture of breeds obviated direct comparison of growth with the standard growth curves. The average gain in body weight from birth to six months of age was 226 pounds in Group I and 232 pounds in Group II. In height at withers, the average gain per calf in the respective groups was 22 and 23 cms. These gains approximate the normal made by purebred Ayrshires in the Kansas State College herd and are probably somewhat below the gains which would be expected from calves of an Ayrshire-Holstein cross. In general, however, the calves appeared thrifty and reacted normally in all respects. Only one calf had digestive trouble and that was of short duration.

Although carotene determinations on the hay used indicated that the calves were receiving sufficient vitamin A, at the end of the trial they were tested for night blindness. There was no evidence of any defect in their sight. Calcium, phosphorus and hemoglobin determinations on the blood made at monthly intervals showed no significant variations from the normal.

P18. Limited Prairie Hay Rations and Avitaminosis in Dairy Heifers.
A. H. KUHLMAN, ANDREW NALBANDOV AND EARL WEAVER, Oklahoma A. & M. College.

During the past ten years more than fifty grade Jersey calves have been raised on a basal ration of milk, prairie hay, and cottonseed meal. In no single instance have any apparent symptoms of vitamin A deficiency manifested themselves, even when low grade prairie hay produced during drouth seasons was fed. In a preliminary phase of a study to determine the vitamin A requirements of dairy cattle for growth, manitenance, reproduction, and lactation, two groups of calves and heifers were fed limited amounts of prairie hay. The average amounts of prairie hay consumed by about forty heifer calves fed prairie hay ad libitum during the first year and of thirty-four heifers during the first gestation period were used as the bases for determining the level of hay intake. One group of calves and heifers was fed one-half as much hay daily as was consumed by animals of the full-fed roughage ration at corresponding ages, while the other group received one-fourth as much prairie hay. Each animal was fed an amount of cottonseed meal sufficient to supply the protein required at the given age for normal growth according to the Morrison Standard. Dried beet pulp and molasses beet pulp were fed in such amounts as were necessary to make the intake of total digestible nutrients equivalent to the Morrison Standard.

To date seven heifer calves have received the 50% hay ration and six the 25% hay ration for periods ranging from six to twelve months. All of these are the progeny of cows which have been fed a ration of prairie hay and cottonseed meal ad libitum and confined in dry lot for years.

Four calves in each group were started on the limited hay rations at birth. The remaining animals received a full prairie hay and cottonseed meal ration for periods ranging from two to nine months after birth. Gains in weight and general development have been equally good and very satisfactory in both lots, when a full hay ration was fed during the first 60–100 days or longer. Symptoms of vitamin A deficiency as indicated by running at the nose, coughing, and blindness have manifested themselves in several instances among the calves started on the limited hay rations at birth.

Four heifers raised on the standard prairie hay ration were also used in this study. At breeding age, two of them were changed to the 50% hay ration and two to the 25% hay ration. During the gestation period all four heifers made exceptionally good gains in weight and were in fact consistently above normal in condition, thriftiness, and weight.

Heifer No. 324 on the average consumed, 6.1 pounds of prairie hay daily, made a total gain in weight of 266 pounds in a 261-day gestation period. Her calf was born before term, weighed forty-one pounds at birth and lived only two days. Eyes of calf were normal. Placental membranes were retained. Heifer had scours several days before calving, and continued to scour after calving. She was weak and slobbered excessively. On the third

day after calving she had a violent convulsion and died within a few minutes. Post-mortem examination revealed a severe case of enteritis.

Heifer No. 331 in a 280-day gestation period on the average consumed 6.4 pounds of prairie hay and made a total gain of 280 pounds. Her heifer calf which weighed 55 pounds, was dead when found.

Heifer No. 338 in a 270-day gestation period on the average consumed 3.7 pounds of prairie hay daily and made a gain of 337 pounds. Parturition was entirely normal. Her heifer calf weighed 57 pounds at birth, and has always been strong and thrifty. After parturition No. 338 has been listless, dull, and refuses to eat well.

Heifer No. 504 in a 272-day gestation period on the average consumed 3.0 pounds of prairie hay and made a gain of 340 pounds in weight. Her bull calf weighed 52 pounds at birth, but was very weak and died in 30 minutes.

After calving, each of the three remaining heifers have been continued on the same ration fed during the gestation period. One hundred and twenty days after freshening, No. 331 produced 21 pounds of milk daily; forty days after calving No.338 produced 15 pounds of milk daily; and fifty days after calving No.504 produced 20 pounds daily.

P19. Limited Grain Feeding of Dairy Cattle. C. E. WYLIE AND L. R. NEEL, University of Tennessee.

This experiment was started in February 1933 and is still in progress at the middle Tennessee Experiment Station, Columbia, Tennessee. There are two groups, of seven cows each, of registered Jerseys which are fed rations as follows:

> *Group I.* (Full grain)
> Alfalfa hay, ad libitum
> Corn silage, 3 lbs. per 100 lbs. liveweight
> Concentrates, 1 lb. to 3 lbs. milk
> Pasture*, April to October inclusive
> *Group II.* (Half Grain)
> Alfalfa hay ad libitum
> Corn silage, 3 lbs. per 100 lbs. liveweight
> Concentrates, 1 lb. to 6 lbs. milk
> Pasture* winter and summer (weather permitting)

Tables I and II show the results for four years:

TABLE I
Feed consumed per cow per year
Four Year Average for Seven Cows

GROUP	RATION	CONCENTRATES	HAY	SILAGE	PASTURE
			lbs.	lbs.	days
I	Full Grain	1836.1	3348.9	4983.7	298.5
II	Half Grain	974.8	2794.4	4328.5	346.0

* Pasture included bluegrass, lespedeza, and sudan grass in midsummer. The remainder of the year it included barley and rye in addition to bluegrass.

TABLE II

Production per cow per year

Four Year Average for Seven Cows

GROUP	RATION	MILK	BUTTERFAT
		lbs.	lbs.
I	Full Grain	6442.9	376.78
II	Half Grain	6265.5	367.96

P20. Some Experiences in Feeding Cattle on Rations Devoid of Roughage. T. W. GULLICKSON, Division of Dairy Husbandry, University of Minnesota.

During the past 15 years many animals have been used in experiments at this station to determine the cause of failure of cattle to thrive on rations devoid of roughage. This report presents data from a few individuals and groups from this large number. These animals were selected because they indicate the effect of feeding such rations under a variety of conditions and also the factor or factors that appear to have been lacking in such a diet.

Holstein calves, kept indoors and fed a normal ration except for a very limited intake of poor quality prairie hay to about six months of age after which only concentrates and a very limited amount of beet pulp was fed, developed vitamin D deficiency symptoms within a few weeks after the removal of the hay from the ration. This included very low blood calcium (as low as 4.39 mgm. per cent), convulsions or attacks of fits and slight stiffness. One animal died during a convulsive attack—blood calcium 4.98 mgm. per cent. Addition of calcium to diet resulted in only temporary and very slight relief, providing viosterol in the diet or exposing the animal to direct sunshine resulted in apparently complete but only temporary restoration to normal. Complete and permanent recovery was attained by feeding cod liver oil or good quality hay.

A Holstein heifer, about 18 months old, was taken from a rickets-producing diet and fed, after breeding, on concentrates plus 1.0 lb. of fair quality alfalfa hay. She was kept indoors. She remained nearly normal in appearance and in blood picture until within about 8 weeks of date of parturition, when swellings began to appear about the body and legs and finally she aborted approximately 50 days before full term. Soon after this the alfalfa hay was discontinued and $CaCO_3$ added, but her condition continued to grow worse. Feeding viosterol also failed to bring improvement, but with the addition of cod liver oil, improvement was rapid. She was bred again followed by normal parturition. Following this her condition indicated lack of some essential factor and was not relieved by supplying additional minerals and cod liver oil. Milk production was rather limited due to periodic fluctuation in appetite. Reproduction again was normal after

she was transferred to normal ration—with greatly increased production over previous lactation.

An aged (10 years) lactating Holstein cow from normal herd ration was placed on diet devoid of all roughage but including some beet pulp. The concentrates mixture included 40 per cent yellow corn. It was designed to be deficient in vitamin D. She was kept indoors. After two months her appetite began to wane, rear hocks became swollen, and later the forelegs and brisket. Addition of $CaCO_3$ was without effect. Feeding viosterol and exposing her to direct sunshine was not entirely effective in restoring her to normal, but either cod liver oil or hay proved to be effective.

From the foregoing and other data it appears that there are several essential nutritional factors deficient or entirely lacking in a ration of concentrates alone for dairy cattle. When such a ration is fed either one or a combination of several of these factors may become apparent, the one first to come into evidence seems to depend on the kind of ration previously fed to the animal, the age of the animal, and the character of the concentrates fed. Some other factor provided in hay, not identified but suggested by the data, appears to be required for high milk production by cows.

P21. **A Comparison of Pasture Returns from Actual Grazing and Clip Plot Methods.** I. R. JONES, H. P. EWALT AND J. R. HAAG, Oregon State Agricultural College.

During the 1935 pasture season, there was available for study a 15-acre irrigated Lading clover and grass pasture. The area was divided into three 5-acre pastures for rotational grazing. The pasture season extended from April 30 to October 1, a period of 154 days.

The 15-acre area was pastured by approximately 39 cows daily for a total of 5,999 cow days or by about 2.6 cows per acre for the season. The average daily production on pasture was 27.00 pounds of 4.86% milk or 30.483 pounds of 4% milk. The average initial weight of the cows taken on the 7th, 8th, and 9th days after pasturing began, was 902 pounds. The average final weight was 1005 pounds, representing an average gain in weight of 103 pounds during the 154-day period.

The average daily supplementary feed consisted of 4.05 pounds of a grain mixture and ¾ pound of oats and vetch hay, equivalent to 3.1 pounds of total digestible nutrients.

The total digestible nutrient requirement per cow has been calculated two ways using the latest Morrison tables. In the first case, a maintenance requirement based on the initial and final weights has been added to the milk requirement. In the second case, maintenance has been calculated on the initial weight and 4.3 pounds of total digestible nutrients for each

pound gain in weight has been added to the requirement for milk production.

Using the first method, the average daily requirement was 17.1 pounds of total digestible nutrients and with the second method 20.8 pounds. Subtracting the 3.1 pounds of nutrients fed in the barn gives respectively 14.0 and 17.7 pounds total digestible nutrients obtained from the pasture per cow. For the 5,999 cow days, the first method gives 83,986 pounds and the second method 106,182 pounds of total digestible nutrients as the returns for the 15 acres for the season.

During the pasture season the herd was rotated from one field to another a total of 18 times. Field 1 was provided with 8 sets of portable gates to protect 14 × 14 foot areas and fields 2 and 3 each with 4 sets of similar gates. A 10 × 10 foot plot from each protected area, was clipped at the end of each pasture period. The areas were clipped with a sickle about one inch above the ground. For the season, clippings were obtained on 96 plots representing 9,600 square feet. The green weight of the clippings totaled 2,289 pounds. The samples were dried and analyzed individually. More than half of the samples showed 18% to 22% dry matter. During the season there was obtained a total of 30.29 pounds of dry matter per 100 square feet or 13,194 pounds per acre. The 15-acre field might thus be expected to have produced 197,910 pounds of dry matter.

No digestion trials have been reported for Ladino clover and grass pasture. If we assume a digestion coefficient of 72% for the dry matter, the 15 acres produced 142,495 pounds of total digestible nutrients. Assuming 60% as the digestibility of the dry matter, the pasture produced 118,746 pounds of total digestible nutrients.

It can be seen from the figures given that results obtained by the clip plot method are considerably higher than the actual returns from pasturing with cattle even when assuming a low digestibility for the pasture herbage and allowing the factor of 4.3 pounds of total digestible nutrients for each pound gain in body weight. It should be pointed out that cows consuming this pasture walked an average of 4 miles daily going to and from pasture for which no allowance has been made in the above calculations.

It would appear that cows will actually utilize only some 75% of luxurious pasture herbage as measured by the clip plot method outlined above.

P22. The Losses of Dry Matter in Corn Silage Stored in Snow-fence Silos and the Cost Per Ton of Storage. J. B. Shepherd, Bureau of Dairy Industry, U. S. Department of Agriculture.

Three temporary snow-fence silos 4 sections high and 15 to 15½ feet in diameter were filled with corn silage on October 6 to 9, 1936. Silos 1 and 3 were lined with special silo paper. Silo number 2 was left unlined. The silos were filled with 32 to 35 tons of well-eared corn having 33.59 per cent

to 36.53 per cent dry matter. Leaves and stalks were about 50 per cent green, and the corn averaged 36 parts carotene per million parts of dry matter. Silo number 1 was opened and the silage fed after 32 days' storage, silo number 2 after 54 days' storage, and silo number 3 after 65 days' storage.

The silage settled more in the unlined silo than in the lined silos. The depth of spoilage on top was no greater for the unlined silo than for the lined silos. However, in the unlined silo the silage spoiled to a depth of 10 to 14 inches on the sides. This spoilage occurred from top to bottom of the silo. There was very little spoilage on the sides in the lined silos. The dry matter content of the good silage was 57.59 per cent of the total dry matter of the material ensiled in the unlined silo, as compared with 89.88 per cent in silo number 1 and 85.71 per cent in silo number 3.

Maximum temperatures attained at the top just below the spoiled silage were 149° F. on the 54th day in the unlined silo, 117° on the 32nd day in silo 1, and 122° on the 48th day in silo 3. Most of the silage in the unlined silo was dark brown to light in color, indicating considerable heating throughout the silo. The carotene content of the good silage removed was only 3.17 parts per million of dry matter for the unlined silo compared with 17.72 for silo 1 and 12.85 for silo 3. Chemical analyses indicated little difference in the chemical changes taking place in the good silage in the different silos. The losses were apparently moderate and confined principally to crude fiber and nitrogen free extract.

Six medium producing cows were fed the corn silage as the sole roughage, with sufficient grain to provide a little excess of nutrients. The good silage from the three silos was consumed at about the same rate. The average consumption of dry matter in the form of silage was 23.75 pounds per head daily. In feeding period immediately following, these same six cows consumed an average of 20.34 pounds dry matter daily in the form of corn silage from an ordinary concrete silo; the latter silage was higher in moisture and acidity than the former. Milk production was equally well maintained, with a low rate of decline, on the silage rations from the four silos.

The materials used in one lined silo consisted of four 50-foot sections of snow fencing, seven lengths of No. 9 galvanized wire (about 25 pounds), seven turnbuckles, and one and one-third rolls of special silo paper (666 square feet per roll). Based on average corn containing 70 to 71 per cent moisture, each snow-fence silo had a storage capacity for 40 tons of green corn.

At the prices paid in 1936, the materials for one lined silo cost $29.26 or a total of $30.72 including one year's interest on the investment at 5 per cent. If used only one year, the cost of materials per ton of storage capacity would be $0.77. If all the materials except the paper lining are used for four years, and a new paper lining purchased each year, the annual depre-

ciation, plus 5 per cent interest on the average yearly investment amounts to $14.69 or $0.37 per ton capacity.

P23.   The Apparent Digestibility and Feeding Value of Apple-Alfalfa Silage. J. C. KNOTT AND R. E. HODGSON, State College of Washington, and Bureau of Dairy Industry, U. S. D. A.

Silage was made from a combination of 80 per cent apples and 20 per cent alfalfa hay. Digestion experiments and feeding trials were conducted each year for two years. The silage was unusually palatable and in the feeding trials with heavy producing cows appeared to be somewhat more valuable for milk production than sunflower silage. The butterfat from the cows receiving apple-alfalfa silage was higher in carotene than the butterfat from cows receiving sunflower silage. The average apparent digestibility of the nutrients in apple-alfalfa silage for the two years was: crude protein 52 per cent; crude fiber 49 per cent; ether extract 47 per cent; and nitrogen-free extract 70 per cent.

The average composition of the apple-alfalfa silage on a dry matter basis was: dry matter 23.0 per cent; crude protein 9.7 per cent; crude fiber 30.9 per cent; ether extract 3.2 per cent; nitrogen-free extract 49.0 per cent; and ash 7.1 per cent. On these bases 100 pounds of the apple-alfalfa silage contained 1 2 pounds of digestible crude protein, and 13.2 pounds of total digestible nutrients.

P24.   Mungbeam Silage for Milk Production. A. H. KUHLMAN, ANDREW NALRANDOV AND EARL WEAVER, Oklahoma A. & M. College.

On account of their ability to withstand prolonged periods of drouth and extremely hot weather and to thrive on rather thin upland soils, mungbeans have been grown quite extensively in many sections of Oklahoma as an emergency hay crop. The results of two feeding trials with milk cows indicate that mungbeans may have considerable merit as a silage crop under conditions which are not favorable for the production of crops usually grown for this purpose.

During the severe drouths of 1934 and 1936 when most crops were failures, golden mungbeans (*Phaseolus radiatus*) attained a height of two to two and one-half feet. Both crops were cut with a grass mower, run through a silage cutter, and ensiled in a small tile silo. In 1934 the mungbeans were quite mature at the time of cutting and had produced very few pods, but in 1936 many pods developed, only a small percentage of which were mature at the time of harvesting.

In both seasons a good quality of silage was obtained. The silage packed much more firmly than either corn or sorghum silage. It did not have the strong odor usually associated with legume silage and was very palatable. Nothing was added to the beans at the time of cutting to aid in preserving them.

In two double reversal feeding trials in which mungbeans silage replaced one-half of the alfalfa hay fed in the check ration, the results indicate that approximately 260 pounds of mungbeans silage replaced 100 pounds of No. 1 alfalfa hay. In both trials there was no significant different in the milk yields of the two rations fed.

The use of mungbeans as a silage crop eliminates the rather large losses due to difficulty often encountered in producing hay of high quality resulting from the shattering of leaves while curing and the development of mold. The considerable waste which occurs in feeding mungbean hay due to the refusal of cattle to eat the coarser stems is also eliminated in mungbean silage.

P25. Molasses Grass Silage as the Sole Roughage Diet for Milk Production and Growth of Dairy Animals. C. B. BENDER, J. W. BARTLETT, H. H. TUCKER AND J. MIXNER, New Jersey Agricultural Experiment Station.

In order to evaluate molasses grass silage as a roughage for milk production, 12 Holstein cows were chosen at the North Branch of the New Jersey Agricultural Experiment Station and were divided into 4 groups of cows each. The animals in each group were balanced according to age, stage of lactation and daily production in preliminary milking period. The groups received as their sole roughage, grass silage alone, grass silage and dehydrated hay, grass silage and corn silage, and corn silage and dehydrated hay. Each group was fed the particular roughage for a 3 week period. A one week transition period was then allowed the animals in the groups in changing to the next roughage. All groups were milked and fed twice a day.

The milk production and body weight reactions by all groups for the 4 feeding periods according to the roughage fed is shown in the following table.

	GRASS SILAGE AND HAY	CORN SILAGE AND HAY	GRASS SILAGE	GRASS SILAGE AND CORN SILAGE
Total milk	9283.9	9183	9081	8869
Ave. daily prod.	36.84	36.44	36.04	35.20
Weight changes by groups	+ 297	− 66	− 114	− 61

Discussion. While this experiment was in progress it was found to be impossible to maintain the intake of grass silage alone and grass silage and corn silage at the calculated intake levels. This no doubt may have had some effect on the productive level and without a doubt it did effect the weights of the animals. From the appearance of the animals it was impossible to determine which feeding group they represented.

From the results obtained in this particular experiment it is concluded that molasses grass silage will replace corn silage or hay in the ration of a

dairy cow without influencing the productive level of the cows to a marked extent. When fed in place of both corn silage and hay the productive level was maintained although there was a slight loss in body weight in the animals in this group. There is no doubt that a change in the grain ration could have overcome the slight loss in body weight manifested by the straight grass silage group.

To determine the growth response of Holstein and Guernsey heifers to a sole ration of either molasses grass silage or molasses grass silage and dehydrated hay, two groups of yearlings and bred heifers were fed during the winters of 1935–36 and 1936–37.

In the molasses grass silage group 20 Holsteins and 22 Guernseys of various ages were used. In the molases grass silage and hay groups 18 Holsteins and 22 Guernseys made up the experimental group. All animals were over 10 months of age and no animals were included which freshened during the feeding trial.

Timothy molasses silage was used in this experiment and the hay was dehydrated mixed hay. The silage averaged 68.0 per cent moisture and 2.7 per cent protein. The hay averaged 12.5 per cent moisture and 11.6 per cent protein. The animals fed grass silage alone were allowed to consume all they could eat. Their average consumption was 46.3 pounds per day. The other group was limited to 31 pounds of grass silage and 6 pounds of dehydrated hay to meet their requirements of dry matter according to Henry and Morrison's standards for growing heifers.

The average gains for the two feeding periods of 110 days each are given in the following table:

Molasses grass silage

	WEIGHT PER DAY	HEIGHT 110 DAYS	HEART GIRTH 110 DAYS
Holsteins	.75 Lbs.	5.3 cms.	5.6 cms.
Guernseys	.58 "	4.7 "	5.1 "

Grass silage and hay

		WEIGHT PER DAY	HEIGHT 110 DAYS	HEART GIRTH 110 DAYS
Holsteins	..	.97 Lbs.	5.6 cms.	7.4 cms.
Guernseys	.	.70 "	5.1 "	6.2 "

Discussion. On the straight timothy silage ration the quality of the timothy as influenced by maturity and the moisture content effected the consumption by the animals. The intake varied between 38.5 pounds daily and 52 pounds. This factor of quality must be given serious consideration if maximum weight gains are to be made. The animals in both groups appeared thrifty and it was impossible to differentiate between the groups.

The condition of the bowels was excellent excepting at the start of the experiment.

Athough the weight gains may be considered subnormal the height gains were above normal when compared to Ragsdale's standards. The molasses grass silage and hay animals made better average weight gains and slightly better gains in height and heart girth. This, no doubt, was caused by the increase in nutrients consumed by this group. With grass silage at $4.60 per ton compared to $7.04 for corn silage, it makes an extremely inexpensive as well as nutritious feed.

P26. Relation of Grass Silage to the Color, Vitamin C and Flavor in Milk from Individual Cows. O. F. GARRETT, C. B. BENDER AND H. H. TUCKER, New Jersey Agricultural Experiment Station.

Molasses grass silage made from mixed grasses was fed to 4 groups of 3 Holstein cows each and to 4 groups of 4 Guernsey cows each from December 1, 1936, to April 12, 1937. The following roughages were fed to the various groups of Holsteins and Guernseys: grass silage, grass silage and dehydrated hay, grass silage and corn silage and corn silage and dehydrated hay. The grass silage and hay was made from grasses which would average 60% timothy, 25% clover and 15% alfalfa. The grasses were ensiled with 70 to 75% moisture; 50 pounds of molasses were added per green ton.

The Holstein cows were used in a reversal experiment of 3 weeks each with 1 week transition period. The groups of Guernsey cows were not changed from their original feed throughout the 19 weeks. The Holstein groups receiving grass silage as the sole roughage or in part showed a slight advantage in both color and flavor over the group receiving no grass silage. The periods were of such short duration, however, that any one feeding period would be materially affected by previous feeds fed to these animals.

Individual samples from single milkings were taken at weekly intervals and were immediately analyzed for fat and yellow color. Each sample was divided into three parts the last two of which were stored in glass bottles in a refrigerator at about 40° F. The first part of each sample was analyzed for vitamin C and immediately thereafter scored for flavor. The second and the third parts were removed from storage on the two succeeding days respectively and were also analyzed for vitamin C and checked for flavor score.

It is concluded from the data studied that:

In the Guernsey groups the color was maintained more uniformly in the groups receiving grass silage as part or all of their roughage.

The roughage ration which contains a high proportion of good quality molasses grass silage is superior to corn silage in its ability to produce milk of high color and flavor.

A significant correlation coefficient of over 0.6 based on data from all the cows indicates a definite reationship between vitamin C and flavor of milk from individual cows. When the vitamin C content is high the flavor of the milk usually will be good.

The yellow color in milk from individual cows bears a relation to the flavor of that milk as indicated by correlation coefficients of over 0.4 and over 0.6 for Guernseys and Holsteins respectively.

A very definite relationship exists between vitamin C and yellow color in milk from individual cows of both the Guernsey and Holstein breeds as indicated by correlation coefficients of over 0.5 and over 0.6 respectively.

The percentage of fat in milk from individual cows has little or no significant relationship to the flavor of that milk according to an analysis of the results on all the samples studied.

P27. Technique Used in Studying Vitamin A Requirements of Dairy Cattle. L. A. Moore, Michigan State College.

Some inconsistency seems to exist between different experiment stations on symptoms produced in vitamin A deficiency. At the Michigan Station xerophthalmia has not occurred. Night blindness has not been noticed except where calves went blind due to a constriction of the optic nerve.

With such variations occurring a more desirable method of detecting and following vitamin A deficiency was sought. Two advances have been made. The first consists of following the level of blood carotene. The method consists essentially of precipitation of the proteins in the plasma by alcohol and extraction of the yellow color with petroleum ether which is then read in a Lovibond Tintometer. It has been found that below certain levels reproductive troubles and symptoms of vitamin A deficiency occur.

The second advance consists of following the condition of the nerve head of the eye by the use of an ophthalmoscope. In vitamin A deficiency papillary edema and clouding of the disc occur. By following these two guides vitamin A deficiency can be diagnosed long before the health of the animals is so injured that they fail to recover properly.

In studying vitamin A requirements the animals are placed on a vitamin A free ration till the blood carotene has been reduced to a certain level and papillary edema occurs. Carotene is then added to the ration to bring the blood carotene up to a certain level, which should theoretically maintain the animal or prevent reproductive troubles. The work has been limited to animals of the Holstein breed.

P28. The Carotene and Color Content of Home-grown Roughage Feeds and the Relation of These Rations to the Carotene, Color and Vitamin A Activity of the Butterfat. R. E. Hodgson, J. C.

KNOTT, H. K. MURER AND R. R. GRAVES, Bureau of Dairy Industry, U. S. D. A., and State College of Washington.

The color of the field cured grass and clover hay used in the experiments indicated in general the carotene content of the hay and the color of the butterfat produced by cows fed exclusively on this hay. Over a three-year period the average carotene content of rations of home-grown hay, grass silage, hay and silage and pasture were 15, 57, 197 and 259 micrograms per gram of dry matter, respectively. When fed to Holstein cows they produced butterfat with average carotene content of 3.6, 6.5, 6.8 and 7.9 micrograms per gram. There was a close relationship between the color and carotene content of butterfat.

The ration of home-grown field cured hay apparently furnished enough of the vitamin A factor for normal body activities, reproduction and the production of butterfat of approximately 50 U.S.P. units per gram. The hay and silage ration produced a butterfat containing 86 units per gram, the grass silage 97 units per gram and the pasture 105 units per gram.

The cows receiving the hay ration secreted on the average of 0.72 per cent of the ingested carotene in the butterfat; those receiving hay and silage, 0.23 per cent and those receiving silage alone, 0.14 per cent.

The carotene content of the butterfat was a very good index of its vitamin A value. The vitamin A activity in the butterfats attributable to the carotene apparently was 11.2 per cent for the hay ration, 12.7 per cent for the hay and silage ration, 11.3 per cent for silage ration and 13.7 per cent for the pasture ration.

P29. Effect of Carotene Intake on the Carotene and Vitamin A Content of Butter.* H. J. SMITH AND E. B. POWELL, Ralston Purina Mills.

Fifteen Guernsey cows were divided into three experimental lots and were fed over a ten month period at three different levels of Carotene intake. The Carotene intakes were determined by frequent spectrophometric analyses of Carotene extracts of both the grain and roughage parts of the ration. At regular intervals samples of butter from each lot were analyzed spectrophometrically for Carotene and biologically for vitamin A.

The average results of the test were as follows:

CAROTENE INTAKE (MILLIGRAMS PER COW PER DAY)	CAROTENE CONTENT OF BUTTER (MILLIGRAMS PER KILOGRAMS OF FAT)	VITAMIN A INTERNATIONAL UNITS PER KILOGRAM
110	1.95	8000
307	3.48	11000
381	5.27	13500

P30. An Attempt to Remove the Vitamin A Suppressing Factor in Soybean Oil by Adsorbents. S. M. HAUGE, J. W. WILBUR AND J. H. HILTON, Purdue University Agricultural Experiment Station.

Experiments at the Purdue Station have shown that soybeans, when fed in rations to dairy cows, interfere with the transference of the vitamin A potency of the ration to the milk fat secreted by the cows. A recent series of experiments has shown this factor to be associated with both the soybean oil meal and soybean oil produced either by the expeller or solvent processes. The factor seemed to be highly concentrated in the oil and some preliminary studies have been conducted in an attempt to remove it from the soybean oil. A sample of crude soybean oil was treated with activated carbon and another sample of oil treated with a synthetic sodium aluminum silicate. These treated oils were then fed to dairy cows and studies made of their effect on the carotene content and vitamin A activity of the milk fat secreted by cows.

The results of this preliminary trial would indicate that activated carbon removed a good portion of the vitamin A suppressing factor in soybean oil, while the other adsorbent was without effect.

P31. The Relation of A.I.V. Alfalfa Silage and Carotene Content of Milk. W. E. PETERSEN, J. B. FITCH AND N. N. ALLEN, University of Minnesota.

Alfalfa hay and A.I.V. alfalfa silage put up from the same field simultaneously under farm conditions were secured. The silage was pronounced excellent and the hay graded U.S. No. 1.

Two groups of 6 cows each were used. Group I was fed silage in period I and hay in period II. Group II was fed hay during period I and silage
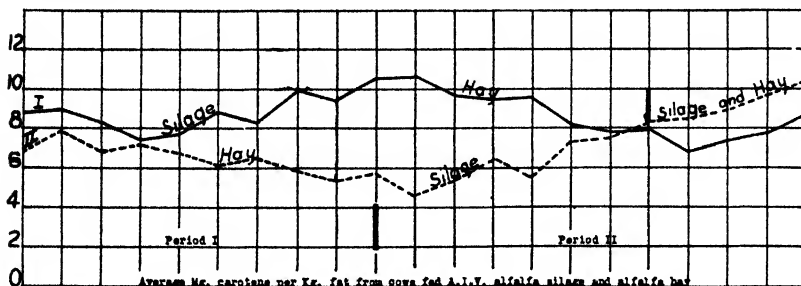
in period II. The roughage was limited to hay or silage in the respective periods with the hay limited to approximate the dry matter furnished in the silage. The remainder of the nutrient requirements were furnished in grain.

Samples of milk were taken and the carotene content in the fat determined colorimetrically every 2 to 3 days. The results are presented graphically for the groups. It is to be noted that the carotene declined when hay

Mg. carotene per kg. fat when fed A.I.V. silage and hay

COW	BREED	BEGINNING		END OF PERIOD I		END OF PERIOD II
A7	Gr. Holstein	4.00		5.04		3.81
421	Holstein	4.09	A.I.V. Silage	6.06	Hay	4.24
440	Holstein	3.64		5.01		5.68
445	Holstein	3.92		4.42		2.94
548	Guernsey	16.00		17.91		16.50
580	Guernsey	10.71		17.92		12.08
A6	Gr. Holstein	4.88		3.62		6.85
217	Jersey	9.36		5.40	A.I.V. Silage	8.96
419	Holstein	6.08	Hay	4.32		7.42
423	Holstein	3.71		2.78		2.98
539	Guernsey	16.80		10.98		19.56
442	Holstein	5.70		3.92		5.86

was fed and increased when the silage was fed. The decline in carotene content of the fat when hay is fed is due to the necessary reduction in amounts of hay to approximate the dry matter in the silage. Prior to the experiment the cows were fed liberal quantities of green colored alfalfa hay.

Difficulty was experienced in getting the cows to consume enough silage. Approximately twice as much dry matter would readily be consumed in the hay as in the silage.

Milk production also declined more rapidly in the silage periods than in the hay periods. Group II was allowed both hay and silage *ad libitum* for 10 days following the close of the experiment when the carotene content of the fat rose markedly.

Marked individual variations were noted in the increases of carotene in the fat. These are presented in the following table:

P32. Effect of Molasses and A.I.V. Silages on the Carotene and Vitamin A Content and the Growth-Promoting Quality of Milk. D. M. HEGSTED AND G. BOHSTEDT,* University of Wisconsin.

The molasses and acid (A.I.V.) methods of ensiling alfalfa have been compared and the effect of feeding such silages on certain properties of the milk has been determined.

Thirty ton lots of alfalfa were put up by each method in 1935 and again in 1936. The first year the green alfalfa had a low dry matter content (22 per cent) and the second year a much higher figure (30 per cent). Blackstrap molasses was applied to the forage at the rate of 100 lbs. per ton in 1935 and 65 lbs. in 1936.

Judged by acidity (pH) ammonia content, the silages were well preserved by both methods. In all four lots the pH value was under 4, and the

percentage of the total nitrogen present as ammonia nitrogen averaged slightly under 10 per cent for the molasses silage and about 5 per cent for the A.I.V. Apparent carotene ranged from 100–200 mg. per kilo but was considerably higher in the A.I.V. silage. No great reliance can be placed on these figures because acid, either applied or developed increases the apparent carotene of forage and silage.

Feeding trials over a period of three months during 1935–36 and again in 1936–37 the animals maintained their weight and produced about the same quantity of milk. Check rations containing alfalfa hay and adjusted to the same nutritive ratio and energy intake gave equally good results.

In 1935–36 carotene and vitamin A determinations were made on the butterfat at the end of the experimental period. No significant differences were obtained among the three groups. Carotene figures for the check, molasses, and A.I.V. groups in order were 6.5, 7.4, 7.6 micrograms per gram and vitamin A 9.0, 10.0, 11.0. Data on the 1936–37 experiment are not complete but preliminary results indicate approximately the same carotene and vitamin A values for the three groups.

Each year milk from the groups was mineralized and fed to rats to determine its growth promoting quality. The differences obtained were very slight and the milk was uniformly good from all the groups both years.

P33. Oxidized Milk Flavor as Related to Carotene, Lecithin and Vitamin C. C. H. WHITNAH, W. H. MARTIN AND G. H. BECK, Kansas Agricultural Experiment Station.

Some investigators have reported that the occurrence of oxidized flavor in milk may be associated with such normal constituents of milk as carotene, lecithin and vitamin C. This investigation was initiated to determine the relationship between these constituents and oxidized flavor of milk.

Samples of morning milk from the four breeds of dairy cows in the college herd (60–70 head) were collected in glass bottles on three consecutive days during the months of December to April inclusive. The cows were fed various winter rations but they were not on pasture during the trial. The milk was examined while fresh and again after three days storage at 45° F. for the presence of off flavors, and tested chemically for vitamin C. The amounts of lecithin in the milk were determined by testing samples taken at various intervals, and the amounts of carotene were estimated from color determinations made on the milk fats. The oxidized flavor was detected in 12.7 per cent of the 922 samples examined during the regular monthly herd test.

Records were kept of rancid flavors and other off flavors which may have been due to feed or to storage conditions. No certain relation was found between any of these off flavors and the development of a flavor which could be definitely characterized as oxidized.

Some investigators have been able to prevent oxidized flavor by the addition of vitamin C to the milk. In this study only the vitamin C naturally occurring in the milk was considered. The rank of the breeds according to average vitamin C content of milk was: Jersey, Guernsey, Ayrshire, Holstein. The frequency with which oxidized flavor developed was in the reverse order. Within the breed, however, there was no relation between the amount of vitamin C and the development of oxidized flavor in milk from individual cows.

From results obtained in this experiment milk of low lecithin content developed oxidized flavor just as readily as milk of high lecithin content.

All samples which developed oxidized flavor were below the breed average in intensity of fat color. There were, however, samples low in color which did not develop oxidized flavor. It has been previously shown that the oxidized flavor of milk could be improved by the addition of carrots and dehydrated alfalfa to the ration. It was decided to increase the amount of carotene in the ration fed to selected groups of cows producing badly oxidized milk. Three cows were fed dehydrated young oat plants at the rate of two pounds per head daily. A carotene concentrate soluble in fat solvents prepared by "Nutritional Research Associates, Inc.," of South Whitley, Indiana, was fed to one cow at the rate of four pounds daily, and to two other cows at the rate of one pound per head daily. The oats contained 103 mg. and the carotene concentrate 150 mg. of carotene per pound. Oxidized flavor was never entirely eliminated by feeding dehydrated oats, but the flavor was greatly improved. The flavor defect was entirely eliminated in two to four days by feeding the concentrate. One pound of concentrate seemed to be as efficient as four pounds in improving the off flavor. The color of the fat was not increased for some time after the flavor was improved.

P34. The Vitamin D Requirement (U.S.P. Units) for Growth and Well-Being of Calves from Birth to Six Months of Age. S. I. BECHDEL, NEAL W. HILSTON AND N. B. GUERRANT, The Pennsylvania State College.

The main object of the study reported herein was to establish definite data on the U.S.P. unit requirement of vitamin D for growth and well-being of calves from birth to six months of age.

Thirty-three grade Holsteins were used as experimental subjects. They were kept in a darkened stable and confined in individual box stalls. Wood shavings were used for bedding.

The basal ration was made up largely of the following concentrate mixture:

50   parts old yellow corn
20   parts gluten meal
20   parts ground oats
7½ parts soybean oil meal
2   parts precipitated chalk
½   part common salt

Whole milk was fed for the first four weeks on experiment. Dry skim milk was then included in the ration until the calves were past four months of age. Domestic dried sugar beet pulp was used as the sole roughage.

A commercial preparation of carotene was fed (average 7500 U.S.P. units of vitamin A) daily to each calf to insure an adequate supply of vitamin A.

All feeds and vitamin carriers were carefully assayed for vitamin D. Activated yeast and cod liver oil concentrate were fed to different groups at levels ranging from 100 to 500 vitamin D units per 100 pounds live weight per calf per day. A balling gun was used in administering these vitamin supplements.

Weekly determinations of the inorganic blood phosphorus and calcium were made. X-ray photographs of the distal end of the left ulna were taken every two weeks.

Rickets in a mild to severe form appeared in the control animals at four to five months of experiment. The data to date indicate quite clearly that the average minimum requirement is 300 U.S.P. units per day per 100 pounds live weight from birth to six months of age. Cod liver oil concentrate and activated yeast were equally effective in the prevention of rickets. The data justify the conclusion that the units of vitamin D from activated yeast and cod liver oil concentrate are equally effective in preventing the onset of rickets in calves.

P35. Studies on Methods of Concentrating the Vitamin D of Butterfat for Assay Purposes. G. C. WALLIS, Dairy Dept., South Dakota State College.

The method of concentrating the vitamin D of butterfat for assay purposes as outlined by Bechtel and Hoppert (Jour. of Nutrition 11: 537–549) was being used in connection with some of our research work. Difficulties were observed which seemed to indicate that all of the vitamin D in the butterfat was not being recovered in the concentrate. It was found upon further study of this point that only about 50–75 per cent of the vitamin D of the butterfat was being recovered. Some variations of the method were tried but without any notable success in recovering all of the vitamin D. These experiences have been reported as a caution to other workers who might be attempting to concentrate the vitamin D of butterfat to facilitate the assaying of relatively impotent samples.

P36. X-Ray Technique for Studying Rickets in Calves. S. I. Bechdel and Neal W. Hilston, The Pennsylvania State College, and Robert F. Light, Fleischmann Laboratories, New York.

In a study of rickets in calves covering the period from birth to six months of age x-ray photographs of the distal end of the left ulna were taken every fourteen days. A general Electric, Model F, portable set was used. A 5×7 film was used and the tube was set uniformly at thirty inches from the cassette. Exposure ranged between one-half to three-fourth second. The epiphyseal line at the distal end of the ulna was observed to be quite wide in all calves at ten days of age. The control animals which developed rickets tended to maintain the original wide line throughout the experiment.

The calves that were given vitamin D supplements in proper amount displayed a rapidly closing epiphyseal line. This observation was in very close accord with inorganic blood calcium and phosphorus data. The equipment and technique described herein is recommended as being highly satisfactory in studying calcification of bones in living calves. It gives promise of being a relatively quick and inexpensive method.

P37. Effects of a Vitamin D Deficiency on Mature Dairy Cows. G. C. Wallis, Dairy Dept., South Dakota State College.

This is a progress report of an experiment in which mature dairy cows have been subjected to vitamin D deficient conditions by keeping them indoors at all times and using a ration consisting of 15 pounds of molasses beet pulp for roughage with a grain mixture of corn, oats, and corn gluten meal to balance the ration. A bone meal supplement has been used to insure an adequate supply of calcium and phosphorus for normal conditions and additional vitamin A was provided by a special concentrate.

The vitamin D deficiency manifested itsef in several ways. Cows producing liberally showed a decline in the total calcium and inorganic phosphorus of the blood plasma. In severe cases the calcium would decline to one-half or two-thirds of the normal level and the inorganic phosphorus to about one-fourth of the normal. Balance trials run while the animals were deficient in vitamin D showed that marked losses of calcium and phosphorus were being sustained. As the deficiency progressed the animals developed a typical rachitic stiffness and enlargement of the joints with bending of the knees and humping of the back. It became very difficult for the animals to walk, get up, lie down, or turn around. Some loss of appetite was usually exhibited.

Upon the administration of vitamin D, as viosterol, with no other change in the ration, the level of blood calcium and inorganic phosphorus showed a noticeable improvement in three days and was usually back to normal in about two weeks. The negative mineral balances were converted into large

retentions, as for example, about one-half pound of calcium and one-fourth pound of phosphorus in a ten-day trial. The appetite would improve and the stiffness and swelling would begin to disappear in a week or ten days leaving the animal seemingly normal in this respect in a month or so.

The fact that such decided manifestations of a vitamin D deficiency have been exhibited by mature animals lends considerable significance to these observations. Preliminary studies on several other phases of this interesting problem have already been made.

P38. Irradiation of Milk; the Interrelation of Radiation Intensity and Milk Film Capacity. H. H. BECK, H. C. JACKSON AND K. G. WECKEL, University of Wisconsin.

Observations made in connection with studies covering the irradiation of milk showed that there is an optimum response by milk to activation by ultra violet radiation under a particular set of conditions, and this led to the study of the effect of varying the conditions over a wide range. A rectangular stainless steel surface 36″ x 36″ and a quartz mercury vapor arc centered on each milk film were employed for the studies. The line test procedure was used to determine the antirachitic potency of the milk.

It was found that for any film capacity from 90 to 1350 lbs./hr./ft. optimum response by the milk was uniformly obtained when the mercury vapor arc was 6″ from the milk. This distance for optimum response was found to prevail for any active radiation intensity between 1000 and 7000 mw./cm.^{2} on the milk film.

The vitamin D potency of milk varies as a parabolic function of the total applied active radiant energy from an arc source at any fixed distance from the milk film. This relation was found to prevail when either the film capacity or radiation intensity were varied. For example, the increase in potency obtained by reducing film capacity by one-half is exactly equivalent to that obtained when doubling the intensity of the radiation of the milk.

Extension of these studies to the carbon arc have provided preliminary results which indicate that the distance for optimum response by the milk to these powerful arcs is between 4 and 12 inches.

P39. Hair Pigment. W. E. PETERSEN AND W. M. SANDSTROM, University of Minnesota.

When very thinly sectioned or finely ground black bovine hair is examined microscopically the pigment granules appear red. Only when these pigment granules are closely packed do they present a black appearance. To secure more information as to whether or not the pigment particles of different colored bovine hair are the same, the pigment was isolated from hair and dispersed in various amounts in a casein glue which was then drawn out to hair-like threads. By varying the concentration of the pigment (isolated from either red or black hair) in the casein glue, it was

possible to produce "artificial hair" varying in color from a light yellow to a black.

The diameter of the hair also influenced the color, the artificial hair of larger diameters being darker in color than those of fine texture.

Chemical analysis of the pigments from different colored hair are now being made.

P40. The Relation of the Endocrine Glands to the Inheritance of Milk Secretion.* C. W. TURNER, Dairy Husbandry Dept., Missouri Agricultural Experiment Station.

Breeders of dairy cattle constantly wonder why the daughters of a sire may vary so widely in their capacity to secrete milk. Some daughters may produce two or three times as much as others even when of about the same size and apparently of similar external conformation. In a study of this problem Eckles and Rood (1910) reported that the main difference between profitable and unprofitable dairy cows is not to be found in the coefficient of digestion or in the amount of food required for maintenance. The superior cow is simply one with a large capacity for using food above the maintenance requirement and one that uses this available food for milk production.

Since this classic work little progress has been made in further analyzing the physiological differences between low and high producing dairy cattle. There is a tendency to say that poor producing cows have inherited a low capacity for milk production, which is entirely true, but what has not been widely recognized is that the inheritance received has a definite physiological and anatomical basis. It is believed that the recent developments in the field of the endocrinology of milk secretion at least furnish the explanation of the physiological differences between cattle of low and high milk production.

Within the past few years, the evidence of the key importance of the pituitary gland in relation to the control and regulation of the other endocrine glands has increased enormously. It has been shown that the pituitary secretes hormones which stimulate the ovaries and testes, the growth and secretion of the mammary gland, the thyroid and parathyroid, the adrenals and possibly other glands. In addition the pituitary secretes hormones which influence milk secretion indirectly through their effect on the metabolism of carbohydrate, fat and protein which regulate the precursors of milk in the blood.

Studies have shown that individual hormones of the pituitary and the glands so stimulated have increased the milk production of individual cows from 10 to 50 per cent. These observations show that when hormonal deficiencies of dairy cattle are corrected these animals are capable of greatly

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station Journal Series No. 513.

increased milk production. While it may be found practicable and feasible (by the discovery of cheap sources of the hormones) to try to correct individual glandular deficiencies, the greatest importance of the discoveries in the endocrinology of milk secretion is in relation to the selection and breeding of better cattle, in other words, a new method of studying the inheritance of milk secretion.

In short the proposed method is to determine the endocrine deficiencies which are suppressing the milk production of individual cows; by (1) the determination of the increase in milk production when individual hormones are administered, by (2) the determination of the amount of the hormones in the blood during maximum lactation, or by (3) the rate of excretion of the hormones in the urine. In this way the several pituitary factors influencing directly and indirectly the growth and secretion of the udder would be determined. This information will explain for the first time exactly what in their constitution has made it possible for the high producing cow to transform large quantities of nutrients into milk and which endocrine deficiencies have limited the production of others.

With the ability to gain this information about the endocrine constitution of dairy cattle, a number of experiments of basic importance could be conducted. (1) Study the mode of inheritance of each gland complex by mating groups of cows low (or high) in any character with a sire who had produced daughters distinctly above (or below) their dams in this character. (2) Use this tool for the selection of cattle to continue as foundation animals in a herd. (3) To explain why the daughters of a sire in one herd may show great improvement and in another herd might be mediocre. (4) By the discovery of the chief deficiencies and excellences of the families of dairy cattle it should be possible to bring together those individuals which would supplement the deficiencies and thus combine characters which would result in the production of milk far above the present standards.

In the future, the endocrinologist will serve the dairy cattle geneticist in the same capacity as the chemist serves industry in the control of manufacturing processes.

P41. Evaluation of Different Measures of Inherited Producing Ability in Dairy Cattle.[1] GORDON E. DICKERSON, University of Wisconsin.

Many different types of production records have been used or proposed for use in measuring the relative inherited producing ability of dairy animals. Among the more important or widely used, are the C.T.A. yearly, the first 240 days, 305 days, and 365 days of lactation, and the total lactation production.

The data studied include the records of Holstein and Guernsey cows which were on D.H.I.A. test during at least their first five lactations. Cows

with records known to be abnormal were not used.   Each cow's production
was measured in terms of all five types of records mentioned.   In all, there
were 1574 of each type of lactation record, and 1434 C.T.A. yearly records,
for 274 Holsteins in 41 different herds.   For 59 Guernseys there were 340
lactation, and 299 C.T.A. yearly, records, in 11 different herds.

Correction factors were calculated for age at calving, calving interval
and lactation length, short previous dry periods, season of calving, age at
beginning of the C.T.A. year and days in milk during C:T.A.year.   Correc-
tion for age, calving interval length, lactation length, and days in milk
during C.T.A. year were based on the average within-cow regression.

Different methods of adjusting actual butterfat records were studied by
analysis of variance, to determine the relative value of each as a measure of
differences between cows in inherited producing ability.

A part of the results for Holsteins are summarized in the accompanying
table.

Apparently any differences between cows in shape of lactation curve
which appreciably affect lactation butterfat production were expressed in
the first 240 days of lactation.

When the average interval between calvings is 13 months or more, little
was gained by correcting production in the first 305 days of lactation for
short calving intervals.   Differences between herds were increased; those
between cows in the same herd were reduced; while variation between records
of the same cow was not changed.

Correcting for season of calving increased differences between records
of the same cow nearly as much as the differences between cows.

The age-corrected production in the first 240 or 305 days of lactation
measured differences in producing ability between cows in the same or in dif-
ferent herds with practically the same degree of accuracy as the first 365 day,
or total lactation production, corrected for age and calving interval or lacta-
tion length.   Correcting for short preceding dry periods (0–3 weeks) further
increased differences between cows in the same or in different herds.

The C.T.A. yearly record, corrected for age, did not seem to measure
differences between cows in the same herd as clearly as the corrected lacta-
tion records, when first year records shorter than 9 months, and later records
shorter than 8 months are discarded.   Using later records shorter than 8
months may increase the differences between cows.   Adjustment to a stand-
ard number of days in milk did not change the percentage of the variance
occurring between cows in the same and in different herds, even though the
total varianse was reduced about one-eighth.

Dividing the age-corrected total lactation production by the interval
between dry dates corrects for very short preceding dry periods.   It also
allows variation due to differences between cows in length of dry period
and length of lactation to remain in the average daily production figure.
Eleven per cent of the intra-herd variance in lactation length and 16 per

cent of that in dry period length was due to differences between cows. To the extent that these differences between cows are hereditary, differences between cows in average daily production due to length of previous dry period and lactation should not be removed, and the above method of correction is justified. This age-corrected average daily production in the interval between dry dates measured differences between cows in the same or in different herds as clearly as any other type of record. It has the added advantage of being a practical measure of relative efficiency of production.

The age-corrected average daily production in the interval between calvings does not correct for short previous dry periods. Only about 6 per cent of the intra-herd variance in calving interval length was due to differ-

Portion of variance due to differences between cows for various types of production records

TYPE OF RECORD	CORRECTED FOR	GROSS STD. DEV.	PER CENT OF TOTAL VARIANCE OCCURRING BETWEEN			PER CENT OF VARIANCE WITHIN HERDS OCCURRING BETWEEN COWS
			All cows	Cows in diff. herds	Cows in same herd	
1st 240 days of lactation	Uncorrected	73.5	33.1	15.8	17.3	20.5
	Age	69.6	44.6	19.9	24.7	30.8
	Age, dry pd.	70.5	46 6	20.7	25.9	32.7
	Age, dry pd., season	72.1	46.0	20.2	25.8	32.3
1st 305 days of lactation	Uncorrected	86.0	34.8	18.0	16.8	20.5
	Age	81.9	45.3	20.3	25.0	31.4
	Age, C. I.	81.5	45.4	21.3	24.1	30.7
1st 365 days of lactation	Uncorrected	94.7	36.0	16.5	19.5	23.4
	Age	91.8	42.9	17.6	25.3	30.7
	Age, C. I.	85.4	46.0	21.1	24.9	31.5
Total lactation	Uncorrected	105.9	33.0	12.2	20 8	23.7
	Age	105.2	37.7	13.7	24.0	27.8
	Age, length lact.	82.4	46.1	20.6	25.5	32.1
	Age, C. I.	86.3	46.2	21.4	24.8	31.6
	Age, C. I., dry pd.	88.0	49.7	22.3	27.3	35.2
Avg. prod. per day— calving interval	Age	0.24	44.6	23.2	21.4	27.9
Avg. prod. per day— pd. between dry dates	Age	0.23	50.3	25.0	25.3	33.8
C. T. A. yearly	Uncorrected	85.6	37.8	20.9	16.9	21.3
	Age	85.6	42.8	22.2	20.6	26.5
	Age, days in milk	80.3	42.6	22.1	20.5	26.3

ences between cows. This may explain why it did not measure differences between cows in the same herd as efficiently as did the age-corrected average daily production in the interval between dry dates.

The fact that each type of record was studied on the same population of cows should be considered in determining the significance of differences in results with the various types of records and methods of correction.

To the extent that cows with five or more successive lactations are superior to those leaving the herd earlier, this study may underestimate the proportion of the variance within herds which is due to differences between cows.

P42. Are Culls Really Culls. D. M. SEATH, Iowa State College.

A study was made of 60 herds in Iowa Cow Testing Associations as a step in determining the part that culling plays in the average herd's production. Each herd had tested for at least 3 consecutive years between 1930 and 1935. Mature equivalent milk and butterfat records were used as measures of a cow's producing ability.

For each of the four years studied the cows were divided into "culls" which were cows gone from the herd the following year and "non-culls" which were still in the herd the next year. Obviously, many of these "culls" left the herd because of disease, injury, old age, death, etc., and not because of low production. Regardless of why they left the herd they no longer influence its average or contribute sons' or daughters to it.

The average butterfat production of the non-cull group exceeded that of the culls by 71, 52, 49, and 32 pounds for the four years studied, the average difference being 50 pounds. In milk production the average difference was 1194 pounds. These differences were all highly significant statistically. The intensity of culling varied from herd to herd to a small but significant amount.

The amount of culling varied significantly from year to year. For the four years 25, 27, 29, and 32 per cent of the cows left the herds. The 32 per cent was in 1934, a drought year, when an abnormal reduction in cattle numbers took place. This year, with the highest percentage culled, showed the least spread in production between the culls and non-culls.

P43. Differences between Records, Real Productivity, and Breeding Values of Dairy Cows. JAY L. LUSH AND FLOYD ARNOLD, Iowa State College.

Data used in proving 103 sires by comparing the lifetime averages of 676 daughters and dams in Iowa Cow Testing Associations were studied to find what share of the differences between single records were really due to permanent differences between the individual cows and what share of those permanent differences were transmitted to the daughters.

The cows mated to each sire were divided into a high half and a low half according to the amount of fat each produced in the first lactation she was tested. Then the later records of the same cows were averaged. Then the records of the daughters of the high group of dams and of the low group of dams were averaged separately. The results in pounds of fat were as shown in table at top of p. 443.

The regression which the later records show from the first records toward the herd average shows the extent to which differences in the first records were caused by temporary circumstances. The repeatability of single records or the fraction of the variance in the single records which was caused by permanent individual differences between cows was 43 per cent in these data.

	HIGH DAMS	LOW DAMS	DIFFERENCE
Average of the records (the first one for each cow) on which the division was made	440.4	338.3	102.1
Average of later records of the same cow	*407.8*	*364.2*	*43.6*
Regression toward herd average	− 32.6	+ 25.9	57%
Average of all records of the daughters	393.4	379.3	14.1

The difference between the average records of the two groups of daughters, when doubled and divided by the average difference between the first records of their dams, measures the degree to which variations in single records are inherited and could be gained in the first generation of selection. In these data 28 per cent of the variance in single records was thus inherited. Only 15 per cent was from permanent characteristics of the cows either not hereditary at all or due to effects which the genes have in certain combinations but not in others (*i.e.*, from permanent effects of environment on the cow herself, from dominance deviations, and from epistatic deviations, all three of these sources of variation lumped together).

By far the most important cause of discrepancy between the record of a cow and her breeding value is thus the temporary environmental circumstances which may be widely different, even in the next lactation. The most effective ways for making selections and progeny tests more accurate are the use of lifetime averages and whatever can be done to standardize environmental conditions or to correct for any unusual conditions which are known to have existed.

Since equal numbers of daughters from high and from low dams were studied for each sire, differences between herds were cancelled from these data. The question of whether those herd differences are due to differences in the average heredity of the cows or to management and other environmental conditions is interesting and is important practically but is not answered here. These findings describe intra-herd differences only.

M1. The Isolation of the Citric Acid Fermenting Streptococci from Butter Cultures. H. C. Olson, Iowa State College.

Tomato agar modified by the addition of small amounts of alpha bromo-propionic acid just before pouring is very useful as a plating medium for the isolation of the citric acid fermenting streptococci from butter cultures and other materials. The citric acid fermenting streptococci grow well in the presence of amounts of the acid that inhibit *Streptococcus lactis*. The concentrations of the acid required to inhibit *S. lactis* vary with the different lots of tomato agar used, but usually range from 0.2 to 0.6 ml. of N/10 solution per 100 ml. of agar. Bromoacetic acid is less useful than alpha bromo-propionic acid because the range over which it is effective is so sharply limited. Other alpha bromo aliphatic acids did not give selective inhibition.

M2. The Correlation between the Organisms Found Microscopically in Butter Serum and the Grade of Cream from Which the Butter Was Made. Theodore Hedrick, Montana State College.

Five hundred and twenty-five samples of butter were studied by the microscopic method to determine the correlation between the microorganisms in butter and the grade of cream from which it was churned. Of the 143 samples of butter churned from cream scoring 93 or above, 91.6 per cent were correctly graded. Of the 126 samples churned from cream scoring $91\frac{1}{2}$ to $92\frac{1}{2}$, 59.4 per cent were accurately determined. Of the 159 samples from cream scoring 90 to 91 per cent, 43.4 per cent were correctly graded, and of the 97 samples churned from cream scoring below 90, 53.6 per cent were accurately graded. Different holding periods, 1 to 30 days, for the butter at 2° to 4.5° C. (36 to 40° F.), did not influence the accuracy of the determination of grades of cream from which it was made.

M3. The Detection of Mastitis by the Brom-thymol-blue Test, Leucocyte Count, and the Microscopic Examination of Milk. A. C. Fay, H. W. Cave and F. W. Atkeson, Kansas Agricultural Experiment Station.

On a basis of routine examination of individual quarter samples of milk from cows in the Kansas State College herd, the animals have been segregated in the dairy barn into three principal groups as follows:

A class—those animals regarded as free from mastitis.
B class—animals regarded as suspicious for mastitis because of a high leucocyte count (500,000 or more per ml.) in the milk from one or more quarters.

C class—cows regarded as positive for mastitis because of the presence in the milk of long-chained streptococci and usually, though not necessarily, a high leucocyte count.

An analysis of nearly 7000 comparative tests leads to the following deductions:

1. The brom-thymol-blue test detected only 21.1 per cent of the samples taken from quarters known to be infected with mastitis.

2. On samples taken from cows diagnosed as free from mastitis, the brom-thymol-blue test gave false readings in only 1.6 per cent of the cases.

3. If a brom-thymol-blue test is positive, there is a 92.7 per cent chance that the cow will be found positive for mastitis on further examination.

4. If a brom-thymol-blue test is negative, there is a 55.2 per cent chance that the cow is actually negative, and hence a 44.8 per cent chance that the test is false.

The value of the brom-thymol-blue test may be summated by the statement that, although it rarely gives a false reaction with a known negative cow, it fails to detect a sufficiently high per cent of the positive cases to recommend it as a sole means of identification of mastitis for segregation purposes.

5. The fact that high leucocyte counts above the arbitrary standard of 500,000 per ml. were found in only 36.7 per cent of the samples actually containing long-chained streptococci suggests that this standard may be too high for proper interpretation.

6. Long-chained streptococci were detected in 85 per cent of replicate samples taken from quarters in which the organism had previously been found. The fact that the organism was not detected in 15 per cent of the samples from these known infected quarters emphasizes the necessity of repeated analyses for positive diagnosis.

7. Leucocyte counts above 100,000 per ml. and the appearance of streptococci in chains of only medium length were frequently found to give forewarning of impending mastitis.

8. Once an animal has been justifiably moved from A-class down to B- or C-class, there is little likelihood that it will be advisable to reclassify her again in A-class. Experience with this herd has shown that, with few exceptions, such reclassifications have been based on false hope.

9. Mastitis was found in this herd in 13 per cent of heifers in their first lactation period, 38 per cent of cows in their second lactation period, and increasingly higher percentages in later lactations.

M4. A Combined Pasteurizer, Cooler and Incubator for Mother Starter.
G. H. WILSTER AND F. E. PRICE, Oregon State Agricultural College.

A tank for pasteurizing and cooling jars of milk for mother starter, and a water-jacketed incubator for the inoculated milk in the jars were designed

and constructed in 1932 at the Oregon Agricultural Experiment Station. (See Bulletin 301: "Design of Equipment and Method for Preparing Starter for Oregon Creameries and Cheese Factories," by F. E. Price, G. H. Wilster and C. J. Hurd.)

This equipment has proven very satisfactory both in the Oregon State College Creamery and in commercial plants.

The tank for pasteurizing and cooling has now been equipped with an electric heater that is connected with a thermostat so that it is possible to maintain a temperature of the water in the tank of 70° to 72° F. during the incubation period. The jars of pasteurized milk, after cooling and inoculation, are placed in the water when the temperature of the water has been regulated to 70° F. The tank is not insulated but it may be found that, under certain conditions, insulation of the tank will be desirable.

The coagulated milk may be quickly cooled by first allowing cold water from the water system to replace the 70° F. water in the tank. Crushed ice is then added to the water to bring the temperature down to 32° F., or cold brine is allowed to flow through a coil that is submerged in the tank. After having been thoroughly cooled the jars of mother starter can be placed in the regular refrigerator. The tank is then ready for the next batch of milk.

With this tank an incubator for incubating the inoculated milk is unnecessary.

Tests show that with a room temperature ranging from 45° to 70° F. during the incubation period, the temperature of the water in the tank (not insulated) can be uniformly maintained at from 70° to 72° F.

M5. Studies upon a Bacteriophage Inhibitory to Streptococcus lactis. F. E. Nelson, University of Minnesota, and B. W. Hammer, Iowa State College.

In most of the bacteria-free filtrates obtained from typically "slow" butter cultures and from many of those obtained from cultures which coagulated normally an ultrafilterable principle which inhibited the growth of certain strains of *Streptococcus lactis* was demonstrated. Under the proper conditions, lysis of a sensitive culture in a liquid medium and the production of plaques on a solid medium could be shown. Propagation at the expense of sensitive cultures of bacteria was accomplished. Resistant strains of *S. lactis* were isolated from the secondary growth of a culture upon which the principle had acted. The extreme specificity of the principle was demonstrated, and the existence of a number of different strains was indicated. The effects of physical and chemical factors upon the principle were studied. The characteristics of the inhibitory principle indicate that it is a bacteriophage active against *S. lactis*.

M6. The Dye Concentration in Culture Media Employed for the Analyses of Escherichia-Aerobacter Members in Milk. H. D.

McAuliffe and A. A. Borland, Department of Dairy Husbandry, The Pennsylvania State College.

Recent work has indicated that one of the limiting factors in tests to determine the presence of *Escherichia-Aerobacter* members in milk has been the culture medium employed. In most instances the concentration of the bacteriostatic agents in these media were developed for use in water analysis. Assuming the possibility of these dyes being absorbed on the milk solids, leaving only a fraction of the original concentration of dye for inhibitory purposes, studies have been made to determine a more desirable dye concentration to be used in milk analysis.

Whole milk was added to lactose broth containing various dye concentrations (ratio: 1 part of milk to 10 parts of broth). This mixture was dialyzed through a semi-permeable membrane, and the amount of unadsorbed dye determined colorimetrically. Results with fuchsin lactose broth show that in order to have the recommended amount of dye available (1 part in 66,500) for bacteriostatic action in the presence of milk solids, the concentration of basic fuchsin should be increased seven times (to 1 part in 9,500). A concentration of 1 part basic fuchsin in 13,300 parts lactose broth was found non-inhibitive to a skim milk suspension of pure cultures of the *Escherichia-Aerobacter* group.

Similar investigations employing brilliant green lactose bile 2.0 per cent showed that the concentration of brilliant green in this medium should be increased two and one-half times, from 1 part in 75,000 to 1 part in 30,000. It is believed that lactose broth employing these higher concentrations of dyes offers a more selective means of detecting the *Escherichia-Aerobacter* organism in milk.

M7. The Effect of Salts on the Growth of Bacteria in Milk. C. S. Mudge and T. G. Anderson, University of California.

Traces of certain elements—Cu, Fe, I, Mn, and Zn—are known to be present in milk. In milk, too, organisms are found which seem to grow best in that environment. Attempts to grow such bacteria in a non-milk medium meet with but partial success. Addition of casein or of lactose aids these bacteria, to be sure, but this growth is less than that found in milk. However, our results reveal that when the salts of the elements mentioned above are added to peptone media, greatly increased growth is obtained.

M8. Comparative Studies on Bacterial Milk Counts in Various Types of Media Incubated at 20°, 30° and 37° C. J. Drexel Dennis and Harry H. Weiser, Ohio State University.

Other types of culture media and lower incubation temperatures, than

those recommended by Standard Methods, have been suggested by some investigators for enumerating the bacteria in milk.

The bacterial counts of 37 composite samples of raw milk produced under average farm conditions were determined on tryptone-glucose-skim milk agar (as proposed by Bowers and Hucker, 1935), nutrient agar plus 0.5 per cent skim milk, yeast extract agar (as suggested by Devereux), and standard nutrient agar. Each inoculated medium was incubated at 20°, 30° and 37° C. for 48 hours and the colonies counted under standardized conditions.

A comparison of the bacterial counts at 37° C. incubation showed that 30 of 37 milk samples gave higher counts per ml. on tryptone-glucose-skim milk agar, 20 on nutrient agar plus skim milk, and 16 on yeast extract agar than were obtained on the standard nutrient agar.

Using an incubation temperature of 30° C., 34 of the same specimens gave higher counts on tryptone-glucose-skim milk medium, 13 gave higher counts on skim milk agar, and 19 were higher on yeast extract agar than on the standard medium.

When incubation was at 20° C., a higher bacterial count than in the standard agar was obtained in 32 of the 37 samples cultured in tryptone-glucose-skim milk medium, in 17 specimens in agar plus 0.5 per cent skim milk, and in 14 milk samples tested in yeast extract agar.

It is apparent that tryptone-glucose-skim milk agar gave higher bacterial counts than any of the other media, when incubated at 30° C. At 20° C. all of the media showed an increase in the bacterial counts over standard agar but the differences were not as great as at an incubation temperature of 30° or 37° C.

Bacteria were transferred to individual tubes of litmus milk from all colonies on the highest dilution plates of all media, for the purpose of determining the variety of bacteria encouraged to grow by the constituents of the individual media. Judging by the greater diversity of reactions in the litmus milk tubes, the tryptone-glucose skim milk agar supported a larger variety of bacteria than any other medium, and this was more evident at 30° than at 20° or 37° C.

M9. A Study of Comparative Methods and Media Used in the Microbiological Examination of Creamery Butter—I. Yeast and Mold Counts. G. W. SHADWICK, JR., Director of Control Laboratory, Beatrice Creamery Company, Chicago, Illinois.

A study of comparative methods for determining the yeast and mold counts of salted and unsalted butter has been made using as culture media freshly prepared potato dextrose agar and dehydrated Difco potato dextrose, peptonized milk, malt, whey and wort agars. Representative data are presented and discussed. The necessity for better methods of determining the mold count particularly of unsalted butters is outlined.

M10. Proposed Standard for the Yeast and Mold Count of Salted Butter Made from Sour Cream. E. H. PARFITT, Purdue University.

A standard is suggested for the evaluation of effective pasteurization and for adequate production practices based on the yeast and mold count per ml. of the finished butter. The proposed standard is based upon the analysis of over 2,000 samples of salted butter made from sour cream, (1) as to the ability of the industry to attain these standards, (2) the attainment of these standards in plants under control, and (3) the influence of method of analysis of the butter on the numbers of yeasts and molds found.

The proposed standard is as follows: Less than 50 yeasts and molds per ml. of butter as representing good conditions of manufacture; 51 to 100 per ml. as representing fair conditions; 101 to 500 per ml. as representing poor conditions; and over 500 per ml. as representing very poor conditions of manufacture.

M11. Studies on Oospora lactis. H. MACY AND D. L. GIBSON, University of Minnesota.

Sixty-one cultures of *Oospora lactis* have been isolated from Canadian and domestic butter and preliminary observations made upon their morphological, cultural and biochemical characteristics. Distinct differences are noted in colony formation, both as to size and appearance, with remarkable variations on several media. The phenomenon of sectoring of colonies is striking, with certain strains showing persistency toward this physiological variation. The size of conidia fluctuates widely even in the same culture. Optimum growth temperatures range from 15° C.–25° C. with restricted growth of most strains at 10° C. certain cultures develop normally at 30° C. while others are practically dormant at such a temperature. Three cultures resist heating at 57° C. (135° F.) for 30 minutes, one at 60° C. (140° F.) for the same period but none surviving after exposure to 62.8° C. (145° F.) for one-half hour. Normal development of these cultures in all cases is disturbed at salt concentrations of 7.5 per cent or higher while only five show any sign of growth at 10 per cent. Growth is meagre at pH 3.0 or lower, generally best above pH 4.0, and luxuriant but somewhat atypical at pH 7.0 or higher. The upper limit of growth for all cultures has not been established definitely. All strains produce indol, liquefy gelatin to some extent, and show lipolysis of cottonseed oil and butterfat. None produce an acid reaction in litmus milk, or hydrolyze starch. Acid is formed in glucose broth in all cases, but gas only in nine instances. Maltose, lactose, sucrose, inulin and salicin are not attacked. Flavors produced in skimmilk, whole milk, cream and starter are not pronounced except by six cultures where fruity to cheesy flavors are evident. Further studies are to be made on

the significance of the varying characteristics of the apparently numerous strains of this species.

**M12.   Pseudomonas fragi and its Importance in Dairy Products.   H. F.
LONG AND B. W. HAMMER, Iowa State College.**

Pseudomonas fragi has been repeatedly isolated at the Iowa Agr. Exp. Sta. from various dairy products and is apparently widely distributed.   It is psychrophilic and samples of raw milk and cream held at low temperatures frequently produce a characteristic odor suggesting the flower of the May apple (*Podophyllum peltatum*).   Later the samples may be rancid.   The species has never been isolated from pasteurized milk or cream directly from the vat but has been found frequently in bottled pasteurized milk and cream which indicates contamination after pasteurization.   Occasionally, cottage cheese develops an off or "May apple" odor due to the growth of *Ps. fragi*. The organism is extremely variable making its characterization difficult; from plates poured with freshly isolated cultures smooth, intermediate and rough colonies may be obtained.   These variants differ to a great extent in their ability to hydrolyze fat and protein.   The most common reaction in litmus milk is a slight acidity, first noticeable at the surface, followed by coagulation, partial reduction and slight proteolysis; other strains, however, produce an alkaline reaction or do not visibly change the medium.   Due to this variability the organism may be found in butter exhibiting a May apple odor, rancidity or cheesiness; it has been isolated repeatedly from both salted and unsalted butter obtained in Iowa and surrounding states.

**M13.   The Manufacture of Sweetened Condensed Whey and Its Use in
Foods.   G. A. RAMSDELL AND B. H. WEBB, Dairy Research Labo-
ratories, Bureau of Dairy Industry, U. S. Department of Agricul-
ture.**

The increasing possibilities for the use of whey in foods call for a whey product that will not spoil and that can be easily processed.   It has been found that whey partially condensed and sweetened can be blended with certain other food products into a nutritious and palatable new series of foods.

The method of manufacture of this sweetened condensed product is simple and economically performed at the source of supply, that is, the cheese factory.   Pasteurized whey is condensed to a total solid content of 75 per cent including the added sucrose which should be 28 pounds for every 400 pounds of whey.   The sucrose is added preferably near the end of condencing.   This finished product will contain approximately a 1 to 1 ratio of whey solids to sucrose, which is sufficient sucrose to preserve it.   The product should be cooled to approximately 30° C. as soon as removed from

the pan and stirred quite vigorously while cooling, so as to produce fine lactose crystals. The procedure is similar to that used by the sweetened condensed milk industry in producing a smooth product. It has been found that while this product increases in viscosity slightly with aging at room temperature, even after four months it is still sufficiently fluid for use. The sweet whey is kept in air-tight containers to prevent mold growth.

Investigation has shown that sweetened condensed whey manufactured as above described can be used in preparing such foods as fruit whips, certain types of candy, and in some foods where it can be substituted for egg white. The material whips readily to a heavy stable foam and with the addition of suitable flavors and colors makes an excellent icing. It should also find a place at soda fountains as topping for hot chocolate and sundaes.

M14. The Manufacture of Non-Foaming Casein. G. A. RICHARDSON, N. P. TARASSUK AND L. B. FRY, University Farm, Davis, California.

This progress report is based on attempts to demonstrate to students the effect of method of manufacture on the foaming tendency of casein. It was found impossible to confirm all the recommendations made and the conclusions drawn in a recent paper (Ind. Eng. Chem. *25*, 1213, 1933).

The results of the investigation indicate that usual fluctuations in the temperature of precipitation and the degree of agitation during precipitation are not the determining factors in the foaming qualities of acid-precipitated caseins. Experiments also indicate that breed, and chronic mastitis exert only a very slight effect, if any, on the foam indices of casein manufactured from the milk. Analyses of 71 commercially manufactured caseins from 6 plants and 35 laboratory samples fail to show any consistent relationship between the fat content and the foaming index of casein unless the fat content is abnormally high. Blending of a low-foaming casein with a high-foaming casein results in a mixture of foaming tendency dependent largely upon the type of the low-foaming ingredient.

Non-foaming or at least low-foaming casein may be made from low foaming skimmilk, buttermilk, a mixture of skimmilk and buttermilk, or skimmilk of abnormally high fat content. To consistently manufacture a low-foaming casein from the general supply of skimmilk it appears necessary to add to the milk some foam inhibitor which is occluded or adsorbed by the casein and which is not removed during the working and drying operations. A foam inhibitor found to be satisfactory and economical is diglycol laurate.

M15. Flexible Milk Plants. W. E. GUEST AND R. W. BALDERSTON, W. E. Guest and Company.

The natural evolution in rural creameries, located outside the city milk sheds, from cream centralizers to creameries taking in sweet cream has resulted in better quality butter and better prices to farmer producers. A

further evolution has come in the plant taking in whole milk and separating cream for market or butter, and making the skimmilk into various marketable products. The problem then becomes one of equipping the plant to make the various products, and also for management to obtain markets and make the products which will give the greatest net return for the liquid milk.

The attached charts show the various products which can be made in a flexible milk plant and show how different items of equipment are used in the different manufacturing processes.
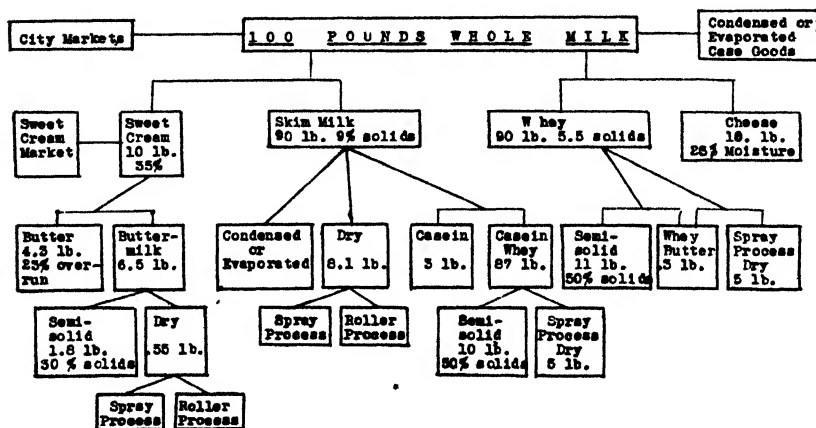
In a flexible milk plant, manufacturing schedules can be changed on very short notice, making it possible to switch from casein production to dry milk powder as markets fluctuate, etc. Since variations in market prices of various milk products show little relationship to their cost of production or yield from a given quantity of whole milk, skillful management can materially increase the net return by adjusting manufacturing schedules to meet market conditions. The paper shows graphically the relationship, based on past markets, of the net return per 100 pounds of milk for these various products, and a basis for management to compute net returns in order to decide which product to make.

M16. Sonic Homogenization of Milk and Ice Cream Mixes. LESLIE A. CHAMBERS, Johnson Foundation for Medical Physics, University of Pennsylvania.

A general theory of the mechanism of emulsification by sound waves of great intensity has been developed. The dispersive action depends on the vigorous collapse of cavities at interfaces between the immiscible liquids. Cavitation will occur in the system wherever local displacement velocities reach a value such that the hydrodynamic pressure is less than the vapor pressure. This follows from Bernoullis law

$$P + \frac{\rho V^2}{2} = k$$

where P is the hydrodynamic pressure, ρ the density of the liquid, and V the velocity. In a heterogeneous system the disruption will normally occur at interfaces.

It can be shown that the number of disruptions and subsequent effective cavity collapses is directly dependent upon the rate of energy transfer (intensity), and upon the frequency of the sound wave.

Development of apparatus for the sonic homogenization of milk and ice cream mixes has progressed to such an extent that satisfactory results are now possible on a commercial scale. A summary of plant scale experiments indicates that the process is sufficiently effective and economical to justify the consideration of the industry at the present time, and points the way to future engineering development of more efficient apparatus through the employment of higher vibration frequencies.

M17. A Suggested Method of Evaluating Homogenization Efficiency by Improved Photomicrography. A. W. FARRALL AND R. L. HANSON, The Creamery Package Mfg. Company, Chicago, Ill.

A need exists for a standardized method of mathematically comparing the efficiency of homogenization. This is of particular value in the design of dairy equipment but should be of real value in the improvement of any dairy product in which homogenization is involved.

It is assumed that although there are other factors which affect the results of homogenization, the principal effect is upon the size and frequency distribution of the fat globules.

It appears that a mathematical comparison of the size and frequency of distribution of the globules, together with weighted homogenization values for certain size globules, can be used to calculate the comparative efficiency of homogenization of various samples.

Authorities are in quite close agreement that a well homogenized sample of ice cream mix, for example, should have the fat globules 2 microns or less in diameter. They also agree that the size of fat globules in unhomogenized milk or cream will average somewhere in the neighborhood of $3\frac{1}{2}$ to 4 microns, and that fat globules of greater than 2 microns diameter are undesirable in ice cream mix.

A technique of photomicrography has been developed which makes use of standard photomicrographic equipment for examination and photographing of samples in which the fat samples are first diluted with distilled water, then suspended in glycerine. The results obtained are superior in that the clusters and groups of fat globules are disturbed the very minimum and by means of improved illumination give excellent photographic detail.

A score card has been prepared for recording size and frequency of the various size fat globules and a formula is presented for mathematically evalu-

ating the percentage efficiency of homogenization, based upon the assignment of certain values to fat globules of each size ordinarily encountered. The values assigned are such that the normal unhomogenized mix will give a calculated efficiency of near zero while a well homogenized mix will show values near 90 per cent.

M18. A Simplified Solids Tester for Ice Cream. KENNETH M. RENNER, Texas Technological College.

A new type vacuum solids tester which can be assembled for a small cost, will be displayed. Results obtained in the testing of ice cream mix for total solids indicate that this method will check very closely with the Mojonnier Method.

The method involves the use of ordinary test tubes for holding the samples of mix. A water vacuum pump to furnish the vacuum and a Pyrex flask containing boiling water used as a heating medium. Thirty minutes is required to complete the test. A regular Butter Moisture Torsion balance is used to weigh the samples.

Total cost of equipment excluding the Torsion balance is approximately twelve dollars.

M19. The Effect of Certain Salts on Properties of Ice Cream Mixes. J. I. KEITH, C. W. RINK AND EARL WEAVER, Oklahoma A. and M. College.

Previously it had been found that sodium citrate and sodium bicarbonate decreased viscosity, fat clumping and titratable acidity (of ice cream mixes) and increased the stability of protein—when measured by precipitation with either alcohol or acid. Calcium chloride gave exactly opposite results in all particulars.

In a series of studies to determine the effect of calcuim chloride and sodium citrate on the development of sandiness in ice cream the following results have been obtained:

When control mix was used no sandiness developed in plain ice cream or in nut ice cream if the nuts had been treated with sugar syrup. When dry nuts were used sandiness developed in four months.

All ice cream made from mix to which calcium chloride had been added developed sandiness. Treating nuts with sugar syrup had little or no effect in retarding the development of sandiness when this salt had been added to the mix.

When sodium citrate was added to mix the development of sandiness was noticeably hastened if dry nuts were used and was slightly hastened when nuts were treated by simply pouring hot syrup over them before canning. No sandiness developed, however, in the plain ice cream or when nuts had been cooked in sugar syrup.

M20. Power Requirements for Freezing Ice Cream. W. J. CAULFIELD,
C. K. OTIS AND W. H. MARTIN, Kansas Agricultural Experiment
Station.

The operating efficiency of a 40 quart direct expansion freezer, operated
with a 3 and 5 H.P. motor and using dasher speeds of 170 and 200 r.p.m.,
was determined. Other facts included in the study were the effect of shut-
ting off the refrigerant at various temperatures, the percentage and kind of
stabilizers used, and the use of egg yolk, on the power requirements for the
freezer and the quality of the finished ice cream.

A reduction in the temperature at which the refrigerant was cut off from
25.5 to 24 and 22.5° F. resulted in noticeable increase in freezing time and
total power required and a reduction in the speed of the dasher. When the
ice cream drawn was at the lower temperatures the body and texture scores
increased slightly.

The use of either gelatine or Dariloid in proper amounts affected the
quality of the ice cream more than did a reduction in the drawing tempera-
ture. The time required for freezing, the total power required, and the score
of the finished ice cream were not significantly different in the case of ice
cream stabilized with 0.35 per cent of 250 Bloom gelatine as compared with
a similar mix stabilized with 0.26 per cent Dariloid. The addition of stabil-
izer to a standard mix slightly increased the freezing time and total power.

When a 5 H.P. motor was substituted for the 3 H.P. no more total power
was required to operate the freezer. The larger motor shortened the freez-
ing time slightly and was never seriously over-loaded as was the 3 H.P.
motor.

The addition of 1.5 per cent frozen egg yolks to the mixes increased the
energy input to the motor to a marked extent when the refrigerant was cut
off at 24° F.

The use of eggs shortened the freezing time, especially when the refrig-
erant was cut off at the lower temperature. No significant differences were
observed in the quality of the ice cream as affected by the cut off tempera-
ture when eggs were used.

By increasing the dasher speed and using a 5 H.P. motor, a slight saving
in time required for freezing resulted. There was a slight increase in the
energy input to the motor but the total power for freezing was not affected.
A change in dasher speed had no significant effect on the quality of the ice
cream.

M21. Sogo Ice Cream. THOS. B. HARRISON AND C. E. WYLIE, University
of Tennessee.

"Sogo" ice cream is ice cream that has been flavored with an improved
grade of sorghum syrup made according to the method developed by the
Agricultural Experiment Station of the University of Tennessee with the

cooperation of the Tennessee Valley Authority. This method of making good sorghum of uniform quality was used by the Cumberland Homesteads as Crossville, Tennessee, also by the Blanche Syrup Association, Blanche, Tennessee.

Frequently, ordinary sorghum syrup goes to sugar after being held awhile. Obviously, such sorghum would not be satisfactory as a flavoring for ice cream. The improved method of manufacture produces a uniform product and prevents the formation of sugar crystals.

In January 1937 several trial batches of ice cream, using varying amounts of sorghum, were made in the University of Tennessee Creamery. Interested parties were called in to pass judgment on the ice cream as to the flavor, texture, and color. From these trials it was decided that the best sample of the ice cream was the one to which sorghum syrup had been added at the rate of 1 pound to 5 gallons of ice cream. The following formula was used for the mix:

Ingredient	Pounds	Fat	Serum Solids
35% cream	25.2	8.80	1.47
4% milk	55.0	2.20	4.77
Skimmilk powder	4.4		4.26
Sugar	15.0		.
Gelatine	.4		
	100.0	11.00	10.50

The above mix was pasteurized at 150°, held for 30 minutes, cooled to 145°, and viscolized at 2500 lbs. pressure. From the viscolizer the mix passed over a tubular cooler where the temperature was reduced to 40°. The next morning the mix was frozen in a 20-quart direct expansion freezer. The sorghum syrup was added to the mix in the freezer. After freezing, the ice cream was hardened and stored at 0° F.

M22. Flavor Defects Encountered in Strawberry Ice Cream Prepared with Commercial Skim Milk and Condensed Milk from Stainless Steel Pans. E. W. BIRD, J. J. WILLINGHAM AND C. A. IVERSON, Iowa State College.

The objectives of this problem were to:

1. Compare the keeping quality of ice creams made with condensed milk from stainless steel pans with that of samples prepared with dry skim milk.

2. Determine whether or not the heat treatment of fat is a factor in the development of the flavor defect by comparing ice cream prepared with 8 per cent fat and skim condensed milks which have been processed in stainless steel pans.

3. Compare the effect of age of condensed milk (from stainless steel pans) on the keeping quality of the ice cream made. The comparison was attempted by preparing ice cream with fresh and one week old skim and 8 per cent fat condensed milks.

4. Further check whether or not strawberries contribute to the development of the flavor defect by comparing storage quality of ice creams from the same mix prepared with and without fruit.

5. Check the hypothesis that copper is contributory in the development of the undesirable flavor from a catalytic standpoint rather than that its presence in any mix might assure the occurrence of the defect. That is, previous work at this station indicates that the rate of development of the flavor is proportional to the copper content in those samples in which the defect occurs but that many samples with equivalent or higher copper contents do not show the defect. It would appear then, that copper does catalyze only those samples which seem to have the tendency to oxidize inherent in them, whereas its presence in samples not so predisposed does not cause flavor defects.

The experimental data indicate that:

1. The copper content of the ice cream samples was not appreciably altered by the addition of strawberries.

2. The stale flavor defect as encountered in this study was very mild and was not pronounced enough to cause a great deal of trouble.

3. The metallic and tallowy flavor defects were very objectionable and the ice cream was unpalatable when they were present.

4. The heat treatment of the fat during the condensing process in stainless steel pans had no apparent effect on off-flavor development.

5. The age of the condensed milk, when stored for one week at 32° F., had little effect on the off-flavor development.

6. Strawberries tended to retard the development of off-flavors.

7. The presence of copper in the ice cream does not assure the occurrence of the defects. The state in which the copper is present appears to be more important. Copper may act as a catalyst but apparently oxidizes only those samples that have the tendency to oxidize present in them.

8. The use of condensed milk prepared in stainless steel pans as a source of added solids in ice cream does not introduce the flavor difficulties that have been encountered when condensed milk from copper pans is employed.

9. The comparison of the flavors of ice cream containing commercial condensed milk processed in stainless steel pans with those containing commercial dry milk as the source of added solids showed that those samples prepared with the condensed milk were superior in quality to those prepared with dry skim milk.

M23. Some Factors Affecting the Serving and Dipping Qualities of Ice Creams.* W. H. E. REID AND W. S. ARBUCKLE, Missouri Agricultural Experiment Station.

This investigation treats with the effect of serving temperature on consumer acceptance, dipping qualities and stability of ice creams and sherbets.

The consumer acceptance was determined by recording the observations made by a comparatively large number of different people who judged seven different flavors of ice creams and four sherbets at serving temperatures of 6, 10, 14 and 18° F. The data indicate definitely that the serving temperature is a factor of decided importance in determining consumer acceptance of frozen desserts.

Ice creams served at 10° F. were considered by a large per cent of the judges, as being desirable in flavor, smooth and mellow in body and close in texture. Those served at 14° F. were considered very slightly objectionable because of the tendency for the flavor to be too pronounced, sweet and warm, the body tended to be slightly lacking in resistance and the texture was slightly open. At 6° F. the ice creams were severely criticized for having a cold, submerged flavor and resistant body. All ice creams were least desirable for consumption when served at 18° F.

Due to the higher sugar content and more pronounced flavor, sherbets were preferred at a slightly lower serving temperature than was ice cream.

As the serving temperature of the ice creams and sherbets was increased, the flavor became more pronounced. A serving temperature of 10° F. imparted the most desirable flavor to the frozen desserts. The flavor was submerged and the ice creams considered too cold when a lower temperature was used. However, the flavor was described as being somewhat too pronounced, sweet and warm when served at a temperature exceeding 10° F.

The dipping studies indicate that smaller portions of ice cream were dipped when temperatures of 6° and 10° F. were used.

Serving temperatures appeared to have little effect upon stability of ice cream; however, the ice creams became undesirable for consumption much faster when the smaller sized dippers were used.

M24. Volumetric Method for the Determination of Diacetyl. H. A. RUEHE AND W. J. CORBETT, University of Illinois.

The authors have developed a simple and rapid volumetric method for the determination of diacetyl in starters. They suggest the following procedure:

1. Prepare starter distillate according to the method suggested by Hammer, i.e., add 40 ml. of 40 per cent $FeCl_3$ to 200 ml. of starter. Steam distill

until 100 ml. of distillate is collected. By this procedure the acetylmethyl carbinol in the starter is changed to diacetyl and this product is distilled off and collected in the distillate.

2. Divide distillate into two portions of 50 ml. each for duplicate determinations.

3. Neutralize acidity of distillate with 0.05N NaOH, using phenolphthalein indicator.

4. Add about 1 to 2 ml. of 30 per cent H_2O_2. (One ml. of the H_2O_2 sufficient to oxidize 100 mg. of diacetyl.)

5. Add one drop of a 0.01 per cent solution of osmic acid. (Take 0.01 gram perosmic anhydride and make up to 100 ml. solution with distilled water.)

6. Allow solution to stand about 3 hours after adding the H_2O_2.

7. Titrate to faint pink with 0.05N NaOH, using phenolphthalein indicator. (Proper end point when faint pink color remains about 20 seconds and after fading one drop of alkali solution will bring back pink color.)

8. Calculate mg. diacetyl as follows:

Ml. NaOH × normality × 43 = mg. of diacetyl in 50 ml. of distillate.
Multiply this result × 2 to obtain total mg. of diacetyl in 200 ml. starter.

This method of determining diacetyl is based on the reaction that H_2O_2 oxidizes one molecule of diacetyl into two molecules of acetic acid.
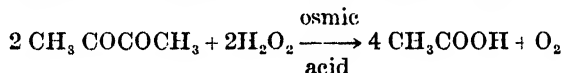
$$2\ CH_3\ COCOCH_3 + 2H_2O_2 \xrightarrow[\text{acid}]{\text{osmic}} 4\ CH_3COOH + O_2$$

M25. The Influence of Heated Testers and Composite Tests on the Babcock Test. P. S. LUCAS, Michigan State College.

Misunderstandings concerning the testing of dairy products cause almost as much unrest among dairy farmers as do prices paid for the product itself. Two factors have been mentioned consistently by producers in Michigan during the past two years. The first of these was their conviction that tests from a properly heated tester were more uniform, were more nearly accurate, and were higher. The second was their belief that composite samples give test results lower than the average of dairy tests. Experimental trials seemed desirable before request should be made for legal regulation of either or both.

Three temperatures were used in testers during the trials made with over 500 samples. The average of samples run in heated testers were higher but statistically the results were not significant. The Mojonnier test gave results averaging .07 of 1 per cent lower than the Babcock. This result, statistically, is significant. Residual fat left in the bulb of the bottle was higher in the case of tests made in unheated testers but so variable as not to be significant.

Due to possibility of evaporation, composite samples should, theoretically, result in higher tests than daily averages. This was not true, however. Selection of samples for eight days taken at random during any month gave practically as good results as daily tests, but four day tests gave such variable results as to make the practice unreliable.

M26. Removal of French Weed Flavor from Cream. W. B. COMBS AND S. T. COULTER, University of Minnesota.

French weed (*Thlaspi arvense*), fan weed or stink grass is known to be responsible for a pronounced obnoxious flavor in milk when consumed by the dairy cow. The use of such chemicals as sodium or calcium hypochlorite, chloramine T, sodium tetraborate (borax) and sodium nitrate in cream intended for buttermaking is unlawful according to Federal and State laws. These chemicals, veiled under certain trade names, are being sold to the creamery industry as sterilizers and in washing compounds. Verbal directions are frequently furnished with reference to the use of these chemicals in the elimination of certain weed flavors, including onion and garlic, from milk or cream. In addition, such products as "Listerine" and brown sugar alone or in combination with other chemicals have been added to cream possessing the flavor of French weed in efforts to overcome the off flavor. Each of these chemicals, in varying amounts, were added to sweet cream possessing a strong French weed and garlic flavor and to sour French weed cream. The butter churned from these creams was examined in the fresh state and after storage.

Boiling the cream in a vacuum pan was the most effective method of treating garlic or French weed flavored cream.

M27. Effect of Temperature on the Rate of Deterioration of Cream. W. H. MARTIN, A. C. FAY AND W. J. CAULFIELD, Kansas Agricultural Experiment Station.

Renewed interest in cream improvement has been experienced in all parts of the country, particularly in the Middlewest, as a result of the Federal Food and Drug Administration efforts to improve the quality of creamery butter. To study the chemical and bacteriological changes taking place, split samples of cream were held at several storage temperatures. The samples were graded daily, and pH, titratable acid, and formol titrations were determined. In two of the six trials yeast and mold counts and also differential and total bacteria counts were made daily on the cream. In one trial starter was added to one part of a split batch of cream for comparison with the part containing no starter. The keeping quality of butter made from cream after it became second grade was also determined in two trials.

Average number days required for cream to become second and third grade when held at various temperatures

	TEMPERATURE OF INCUBATION								
	50	55	60	65	70	75	80	85	90
Days required to become second grade	15	11	10	9	6	5	3	3	2
Days required to become third grade	16	15	13	13	9	8	6	5	4

At 50° F. and 60° F., the rates of growth of yeast and mold were relatively low; whereas at 70° F. or higher these micro-organisms grew rapidly. A close correlation existed between the titratable acidity and hydrogen ion concentration. Both increased slowly at 60° F., but at 70° F. and 90° F. the rate of development was accelerated and the total amount of acid produced was much greater than it was at lower temperatures.

There was nothing in the data to indicate that the addition of starter to the cream to encourage acid production and discourage protein decomposition was feasible. The formal titration was used as a measure of the extent to which protein was broken down. Time, temperature and the addition of starter were factors which affected the formal titration. However, further work will be required before any conclusion can be drawn on the value of formol titration as a measure of cream deterioration.

Butter made from high acid cream, which was only a few days old, deteriorated rapidly on storage. Fair quality butter which stood up well in storage was made from the low acid cream even though it was several days old. The best butter, as to be expected, was made from the fresh low acid cream.

M28. Some Aspects of the Reduction of Acidity in Cream for the manufacture of Butter. E. W. BIRD, N. E. FABRICIUS AND D. F. BREAZEALE, Iowa State College.

Four acid-reducing agents (sodium carbonate, sodium sesquicarbonate, a fused sodium carbonate-bicarbonate mixture and a magnesia (dolomitic) lime) will be reported. Factors investigated over a pH range, in butter, from 5.3 to 8.0 were: (1) Churning losses as percentage total fat churned; (2) comparison of titratable acidity obtained and that desired; (3) comparison of titratable acidity and pH of cream; (4) comparison of pH of cream at churning time and pH of butter serum 3 to 4 days after manufacture; (5) change of pH of butter serum during storage; (6) change in titratable acidity of fat of butter with pH of cream; (7) change of titratable acidity of fat during storage, and (8) correlation of initial and storage scores and flavors of butter with initial and final pH of butter serum.

The results indicate that: (1) Churning losses are minimal in the region pH 6.7 to 7.0 regardless of the neutralizer. This indicates that casein once acid coagulated is not dispersed in a condition comparable to that of sweet cream until the cream is nearly at the neutral point. (2) Non-buffered alkalies (as lime) reduce the acidity of cream linearly to acidities at least as low as 0.0 per cent. Buffered alkalies (*cf.* carbonate combinations) yield linear acid reduction to acidities as low as 0.15 to 0.20 per cent; below these points the rate of reduction of titratable acidity becomes progressively slower. With all neutralizers studied the acidities are lower than desired in the higher ranges and higher than desired in the lower ranges. (3) With the buffered "soda" neutralizers the pH of the cream varies smoothly with titratable acidity from 0.1 to 4.0 per cent acidity. The magnesia lime curve varies smoothly from 0.4 to 0.22 per cent acid; from 0.22 to 0.15 per cent the pH is practically constant indicating precipitation of $Ca_3(PO_4)_2$ and from 0.15 to 0.0 per cent the curve is linear with very sharp rise in pH. (4) The curves for pH of cream *vs.* pH of butter progress smoothly from pH 5.5 to 8.0 when soda neutralizers are used. With magnesia lime a smooth curve is obtained from pH 5.5 to pH 6.25; from pH 6.25 to 7.0 in butter the cream pH varies only from pH 6.3 to 6.6 while above pH 7.0 the two values yield a linear graph. (5) All buffered neutralizers tend to yield a slight increase in pH of butter serum during storage while non-buffered yield random variation with a somewhat greater tendency toward increase than toward decrease in pH. No variations greater than 0.2 pH were encountered. (6) The titratable acidity of the fat of butter progressively decreases with increase in pH of cream (7) Relatively little change in titratable acidity of the fat occurs during storage. (8) The initial pH correlates better with the storage than with the initial score of butter. Regardless of the neutralizer the region of least flavor defect development and of best maintenance of score seems to be pH (initial) 6.7 to 7.5. The pH is apparently not the only factor influencing butter score for the acidity of the fat is of importance. It should be noted in this connection that the fat acidity is a function not only of the pH of the cream at the time of churning but also of the age and quality of the cream.

M29. Studies in the Keeping Quality of Butter Made from Sour Cream.
J. C. FLAKE AND E. H. PARFITT, Purdue University.

The keeping quality was determined on 343 samples of commercial butter made from sour cream. This butter was produced in Middlewestern plants during the period of September, 1936, to February, 1937. The butter was scored, then incubated for 10 days at 15.5° C., and rescored. In addition, chemical and bacteriological studies were made. The results obtained are as follows:

1. Of all samples, 29 per cent did not drop in score during the incubation period; 44 per cent dropped 0.5 to 1.0 point; 15 per cent dropped 1.5 to 2.0 points; 12 per cent dropped 2.5 to 3.0 points.

2. The samples having an original score of 91 or higher showed an average drop in score of 2.0 points; none showing a drop of 0. Those scoring 90 to 90.5 had an average drop of 0.907 point, with 28 per cent not dropping in score. Those scoring 89 to 89.5 had an average drop of 0.748 point, with 45 per cent not dropping. The samples scoring 88.5 or less dropped an average of 0.767 point, with 32 per cent not dropping.

3. The microscopic picture of the butter showed that, in general, large numbers of rod shaped organisms are associated with poor keeping quality.

4. High lipolytic counts of the butter after storage had a tendency to be associated with poor keeping quality. Samples developing a putrid flavor were most marked in this respect. Samples which developed rancid or old cream flavors also tended to have higher lipolytic counts than did the samples which failed to drop in score. High proteolytic counts showed a slight tendency to denote poor keeping quality.

5. Of the samples which did not drop in score, 11 per cent fell in the range of pH 5.5–6.0; 48 per cent in the range of pH 6 0–6.5; and 22 per cent in the range of pH 6.5–7.0. Of the samples dropping $\frac{1}{2}$ to 1 point in score, 13 per cent were in the pH range of 5.5–6.0; 38 per cent in the range of 6.0–6.5; and 33 per cent in the range of 6.5–7.0. Of those dropping $1\frac{1}{2}$ to 2 points, 14 per cent showed a pH of 5.5–6.0; 34 per cent a pH of 6.0–6.5; and 35 per cent a pH of 6.5–7.0. Of those dropping $2\frac{1}{2}$ to 3 points, 20 per cent were in the range of pH 5.5–6.0; 23 per cent from pH 6.0–6.5; and 35 per cent from 6.5–7.0.

6. The pH distribution of samples developing specific off-flavors showed that putrid flavor is associated with the higher ranges, especially around pH 6.75 to 7.25. Those developing old cream flavor fell in the medium range especially around pH 6.25. Those developing rancid flavor fell in the lower range, especially from pH 5.5 to 5.75.

7. In the distribution of samples as to salt percentage, those developing putrid flavors and those not dropping in score tended to be in a lower range than did the samples which developed rancid or old cream flavors. Falling in the range of 2.0 to 2.49 per cent salt were 55 per cent of the samples which did not drop in score and 61 per cent of the samples which developed putrid flavors. In the range from 2.5 to 2.99 per cent salt were 50 per cent of the samples which developed rancid flavors and 44 per cent of those which developed old cream flavors.

M30. Notes on Problems Confronting the Industry on Quality Improvement of Creamery Butter. M. E. PARKER, Chairman of

Research Committee, American Assn. Creamery Butter Mfgrs., Chicago, Illinois.

Quite aside from the problems involved in the procurement of raw cream supplies there are many questions concerning production development and quality maintenance of creamery practices which merit the attention and study of scientific investigators.

While the American Dairy Science Association has been pioneering the application of the Kohman test for the composition of creamery butter, its utility can be seriously threatened unless greater uniformity of results between qualified laboratories can be assured.

The determination of yeasts and molds in butter has proven a boon to those interested in the control of creamery sanitary practices. Yet, present methods using potato dextrose agar have proven somewhat questionable in the examination of unsalted butter, although the newer method of preparing dilutions as indicated by Parfitt has been a distinct improvement.

A virgin field for scientific exploration and also of service is available to the scientific investigator who can solve the problem of the loss in weight in packaged butter. The true significance of the acidity of butter sera, as well as, its proper determination as expressed by pH values is still undetermined. The presence of *Escherichia coli* in butter has not been satisfactorily investigated, nor its significance properly evaluated. The quantitative determination of the color and the vitamin contents of butter produced under a variety of seasonal and sectional conditions can not be long deferred if its nutritional properties are to be maintained or enhanced.

M31. Overcoming the Gummy Body of Butter Caused by Feeding Cottonseed Meal. J. I. KEITH, C. W. RINK AND A. H. KUHLMAN, Oklahoma A. and M. College.

The milk from a herd of Jerseys fed only cottonseed meal and prairie hay and the milk from a similar herd of Jerseys fed a normal ration was collected and separated daily. The two kinds of cream were accumulated and churned. Cream and butter from the former are designated as "cottonseed meal" and from the latter as "normal."

Fifty gallon batches of each kind of cream were pasteurized and cooled in the regular manner. Half of each batch was churned immediately while the other half was held cold for two or four hours before churning.

It was found that when cream was held cold for only 2–4 hours before churning, the "cottonseed meal" cream required 20–30 per cent longer time to churn; whereas previous work had shown that 50–60 per cent longer time was required when the cream was held over night. When churned in less than one hour after cooling, the "cottonseed meal" cream churned in about the same time as the "normal" cream.

When cream was held 4 hours before churning, the "cottonseed meal" butter had a pronounced gummy body. This defect was less noticeable when the cream was held for only two hours; and was not evident when the cream was churned in less than one hour after cooling.

M32. The Lactic Acid Content in Butter, Progress Report. B. E. HOR-
RALL AND W. F. EPPLE, Purdue University.

The lactic acid content of butter and the cream from which the butter was made was determined by the methods of Troy and Sharp, and Friede-mann, Cotoni and Shaffer. These methods were comparable since the results checked within experimental error.

A study was made of the lactic acid content of butter made from cream of various acidities as determined by the regular titration method. The following problems were studied:

(1) Lactic acid was added to the cream to make the titratable acidities of 0.3%, 0.5%, 0.8%, 0.8% neutralized to 0.2%, and 0.8% neutralized to 0.2% and lactic acid added to 0.3%. These various lots of cream were then churned and the resulting butter analyzed for lactic acid.

(2) The above procedure was repeated, substituting a good quality starter instead of lactic acid.

(3) The lactic acid content of twenty churnings of commercial butter was studied. This study included the lactic acid content of the raw cream, cream after neutralization and pasteurization, cream at the churn, butter-milk, and the butter. The pH and titratable acidity were also determined on all samples.

(4) The lactic acid content on various samples of commercial butter sent to the Experiment Station for analysis was determined. These samples were subjected to a keeping quality test consisting of an incubation period of 10 days at 62° F. and another lactic acid determination was made. Some of the samples dropped in score from 1 to 3.0 points during the incubation period.

M33. pH Range of Centralizer Butter. W. H. BROWN AND E. H. PAR-
FITT, Purdue University.

Approximately sixty-five dairy plants, manufacturing butter in Indiana and neighboring states, have been submitting monthly samples of butter to Purdue University for analysis. The hydrogen-ion concentration, expressed as pH, has been determined on the serum of the butter using a quinhydrone electrode.

1. Since March, 1935, the butter manufacturers have been gradually shifting the pH of the butter toward the neutral point, or pH 7.0. In 1935, the pH range of the largest number of samples was from 6.01 to 6.25; in

1936, the range was from 6.26 to 6.50 and to date (April, 1937) the range was from 6.5 to 6.75.

2. The range in pH of 892 individual samples was from 8.0 to 4.15 and of all the samples 9.42 per cent were over pH 7.0; 29.71 per cent from pH 7.0 to 6.51; 38.23 per cent from pH 6.5 to 6.01; 16.70 per cent from pH 6.00 to 5.51; 3.48 per cent from pH 5.50 to 5.0 and 2.24 per cent below pH 5.0.

3. During 1936 no seasonal trend in pH occurred.

4. The pH of the butter produced in some of the plants which have control laboratories varied over wide and narrow ranges.

5. The pH of the samples criticized as having either a slight or a distinct neutralized flavor ranged from 4.15 to 7.96.

M34. Microflora of Cheese Slime. H. MACY AND J. A. EREKSON, University of Minnesota.

Studies have been made of the microflora of the slime appearing on Roquefort, Port du Salut, Tilsit and Limburger types of cheese during the ripening periods. Remarkable changes in pH occur along with modifications of the flora. Cause and effect in this phenomenon are not yet clear. The development of yeasts in the slime of the Roquefort type is followed by a dominance of micrococci and rod forms especially of the *Bacterium linens* type. Microscopic examination of old Roquefort slime revealed degeneration of the bacterial cells, which corresponded with a sudden drop in plate counts.

Rod forms with atypical yeasts were found in old slime of Port du Salut and Tilsit cheese, while Limburger slime showed rod forms in predominance.

The orange pigment-producing rods in the slimes studied apparently were *Bacterium linens* or related strains:

Further studies have been made upon characteristics of the slime organisms and factors influencing the development of the characteristic "rouge."

M35. Making Cheddar Cheeses from Low Curd Tension Milk. J. C. MARQUARDT AND G. J. HUCKER, New York Agricultural Experiment Station.

The low curd tension milk used in these studies was obtained from a herd of cows infected with mastitis. For the experimental work the entire milk production of the herd was used. This included milk from inflamed quarters, although the mixed milk appeared normal macroscopically.

The experimental milk was made into 5 batches of cheese on 5 consecutive days. Two controls from normal milk were also made. The experimental milk contained *Streptococcus agalactiae* and more than 500,000 cells per cc. The experimental milk gave very low curd tension readings by the

Hill and Miller tests.   It fell within the range of soft curd milk.   Using these tests without $CaCl_2$ or HCl added there was no curd formation.   Likewise the experimental milk did not form a curd in the Marschall Cup test.   Titrations and pH value determinations indicated that the normal milk was more acid in reaction than the milk from the experimental herd.

It was possible to make the experimental milk into satisfactory cheeses by using 0.5 to 1.0 per cent of starter plus 30 per cent HCl at the rate of 100 cc. per 1000 pounds of milk.   This was not recommended because of technical limitations and the dangers involved in adding inorganic acids to food products.   By adding starter ranging from $1\frac{1}{2}$ to 3 per cent it was possible to make satisfatcory cheese from the experimental milk.   For this procedure the Marschall Cup or a like test is imperative.   The limitations of this suggestion in practice is the lack of clean starters and the unwillingness of most cheese makers to use more than 1 per cent of starter.

These studies were not intended to encourage making cheese from mastitis milk.   It is hoped that milk of this kind will gradually be reduced to a minimum in cheese sections.

The controls and the cheese made from the experimental milk were rated at 3 regular periods ending with a 9 months' inspection.   The cheeses were scored by 3 station men and by 2 cheese dealers.   The ratings of all were comparable without significant deviations.

Streptococcus agalactiae survived in the cheese at the close of the 9-month scoring period.

Field experiments indicated that dealers are experiencing difficulties with cheeses made from mastitis milk supplies.   Many unusual practices without scientific foundation have been introduced by the industry in an attempt to make favorable cheeses from mastitis milk.

M36.   Curd Tension Measurements.   L. H. BURGWALD AND T. V. ARMSTRONG, Ohio State University.

Four different types of curd knives were used in this study.   The average of the curd tension measurements secured with the American Curd-O-Meter was approximately four grams higher than those secured with the original Hill knife, with the Sommer knife and the Submarine knife giving tensions between these two limits.

Two separate readings were secured during each curd measurement with the knives which operate with a downward thrust: (1) the maximum curd tension, or that reading observed when the knife is cutting through the surface of the coagulum, and (2) the actual tension, secured while the knife is cutting through the body of the curd.   The American knife exhibits an average variation, between this actual tension and maximum tension, of 8.3 grams.   The difference shown by the Sommer and Submarine knives are 2.6 grams and 6.4 grams, respectively.

Increasing the cutting speeds of the knives resulted in a lowering of curd tension measurements, while decreasing the speed resulted in a corresponding increase in these measurements for the few samples that were tested in this manner.

Twenty-seven coagulants were used consisting of variations in amounts of the Hill Reagent and variations in volume and concentration of hydrochloric acid containing different percentages of pepsin.

The reduction of the Hill Reagent to 6 cc. amounts resulted in increased curd tensions in each case.

The use of 10 cc. of N/10 HCl gave curd tension measurements slightly greater than those obtained with the same amount of N/6.67 HCl, the pepsin content being the same in each determination.

Slight increases in pH of the mixtures of milk and coagulant contributed to a tendency toward higher curd tensions, while decreases in pH showed a corresponding decrease in curd tension. The use of 10 cc. of the Hill Reagent resulted in mixtures which gave lower pH readings than were found with any coagulant used, except those where the concentration of HCl was greater than N/6.67.

Variations in time between adding the coagulant and cutting the curd exerted an appreciable influence on the resulting curd tension. The curd tensions increase with increased setting time; only minute variations from the standard ten minute period had no appreciable effect.

The addition of coagulant to the milk as compared with the addition of milk to coagulant resulted in a marked difference, both in the resulting curd tensions and the character of the curd. Twenty-seven comparative tests made, using three different samples of milk, gave average actual tensions of 26.1 grams by adding the milk to the reagent, while the same milk with coagulant added, gave average actual tensions of 58.9 grams.

M37.   The Effect of Varying Storage Temperatures and The Effect of Coverings on the Ripening of Cheddar Cheese. W. G. McCubbin and E. L. Reichart, University of Nebraska.

Part I—Twelve-ounce prints of Cheddar cheese were ripened in valve-vented cans at 70° and 40° F. or combinations of these two temperatures and scored at 1, 2, 3, 4, 5, and 6 months of age. Cheese ripened at 40° F. continuously was superior in both body and flavor. Cheese exposed to the 70° F. temperature for any appreciable length of time became very gassy and developed a fruity, fermented flavor.

Part II—Five-pound oblong loaves of cheese were covered with paraffin, paraffin plus cellophane, and parafilm, and some of these loaves were ripened at 70° F. and some at 40° F. Cheese ripened at 40° F. developed a much milder flavor and lost less moisture than cheese ripened at 70° F. Loaves covered with parafilm and paraffin plus cellophane developed an unclean

flavor which was not prevalent in the paraffined cheese. This unclean flavor was especially noticeable in the cheese ripened at 70° F. Comparative moisture tests at the end of the fifth month of ripening revealed that the parafilm covered cheese contained about 2% more moisture than the cheese covered with paraffin plus cellophane, and the cellophane covered cheese contained from 3 to 4% more moisture than the paraffined cheese. Mold growth was very prevalent on the cheese covered with cellophane.

M38.   Cheese Freezing and Curding Investigations.   J. C. MARQUARDT, New York Agricultural Experiment Station.

The disadvantages of storing cheeses for long periods of time at a few degrees below their freezing points is apparent to those who handle cheese. Previous investigators have shown certain limitations of freezing and holding cheeses at temperatures ranging from 0 to – 10° F.

This investigation was planned to study the problem of freezing cheeses as a means of studying certain curing changes. Its practical application deals with the freezing of a wide variety of cheeses for storage and quality reasons.

Several noteworthy observations have been made. It has been possible by freezing and storing at – 10° F. to retard the development of a bitter flavor in Limburger type cheeses. It is well known that the control of this defect is difficult when Limburger type cheeses are stored at 34° F. for periods ranging from 9 to 12 months.

The texture of aged cheddar cheese has been improved by freezing and storing at – 10° F.

It has been possible to freeze successfully and to hold at low temperature the following cheese variations: Muenster, Limburger, cheddar, camembert and low moisture content grating type cheeses.

The advantages of removing the cheeses directly to a 70° F. room from the – 10° F. room are being compared with placing the cheeses for an 18-hour period at 34 to 40° F. before placing them in a 70° F. room.

Freezing cheeses for prolonged periods of time offers chances for studies in the fundamentals of cheese ripening. For example, pH control with prolonged cold storage periods at – 10° F. will afford a chance to regulate bacterial growth and enzyme activity to a degree estimated to be sufficiently sensitive to make certain general observations at least concerning the active agencies in the curing of cheese.

Curing investigations have revealed that temperatures and humidities employed must be selected for more than flavor production in the cheeses. Rind formation is very essential.

The advantages of holding cheddar type cheeses for a period of time (above 10 days) before being cured at 34° F. over placing them in the 34° F. room within a few days after making is also being studied.

These apparently simple matters are rather difficult to solve due mainly to the wide range in quality of commercial cheeses when compared to experimental cheeses.

M39. Studies Relative to an Open Flame Method for Determining the Moisture Content of Cheddar Cheese. I. A. GOULD, Michigan State College.

A preliminary report of studies being carried out to determine the practicability and accuracy of using a method for determining the moisture content of cheddar cheese similar to the open flame method generally used for butter. Dried olive oil was used in the moisture pans in an effort to prevent the cheese from sticking and burning during heating. Analysis of 31 non-sputtering samples of cheese were made in which results secured by the olive oil-open flame method were compared to those obtained by the use of the Mojonnier method, slightly modified, and by the use of the steam pressure oven operated at approximately 85 pounds pressure. The average moisture values for the samples were 36.45 per cent by the Mojonnier method, 37.19 per cent by the steam oven method, and 36.75 per cent by the oil method. Approximately 40 per cent of the cheese samples encountered sputtered too badly to be accurately analyzed by the olive oil method. Also, when this method was used, the cheese particles usually tended to lump together and to stick to the bottom of the pan during the heating process. The addition of approximately one gram of sodium chloride to the oil prior to addition of the cheese, prevented sputtering in practically all cases, and also prevented the cheese from lumping and sticking. The average moisture content of 20 samples of cheddar cheese by the salt-olive oil procedure was 36.61 per cent as compared to an average of 36.06 per cent by the Mojonnier method. An analysis of 17 samples showed the salt-olive oil method to give results averaging within 0.1 per cent of those secured on the same samples using the steam oven at 85 pounds pressure.

M40. The Homogenization of Milk for Blue Cheese. C. B. LANE AND B. W. HAMMER, Iowa State College.

Comparisons of cheese made from unhomogenized and from homogenized milk have been continued. With the homogenized milk a somewhat different making procedure is necessary than with unhomogenized milk. After a few weeks ripening, the cheese made from homogenized milk began to develop a blue cheese flavor, and after 2 or 3 months considerable of the sharp, peppery flavor was present. With the control cheese, no blue cheese flavor was detected for 3 or 4 months and then the flavor was commonly still somewhat unclean and lacking. In general, cheese made from homogenized milk was soft in body and had a relatively light color, while the control cheese was comparatively hard and yellow in color.

Studies on the volatile acidity of the cheese and the acidity of the cheese fat showed that the values obtained on the cheese made from homogenized milk were two to four times as high as those obtained on the control cheese. Cheese made from milk which had been pasteurized and then homogenized gave higher values than the control cheese but the values were considerably lower than those obtained on the cheese made from raw homogenized milk.

Cheese made from cows' milk or goats' milk, with and without homogenizing, was compared. Data on the flavor during ripening showed that, in general, the cheese made from homogenized cows' milk scored highest while that made from homogenized goats' milk was the next highest. The cheese made from milk not homogenized still had very little flavor after 3 or 4 months' ripening.

M41. Studies on the Ripening of Blue or American Roquefort Cheese. S. T. COULTER, W. B. COMBS AND SPENCER GEORGE, University of Minnesota.

A rather extensive experiment has been completed attempting to determine the effect of variations in acidity at the various steps in the manufacture of Blue or American Roquefort cheese, on the rate of ripening and the quality of the cheese. Factors varied were the amount of starter, the acidity of the milk at setting, the acidity at dipping and the acidity at hooping.

The observations included the hydrogen ion concentration during various stages of manufacture and ripening and the fat hydrolysis and protein decomposition at regular intervals during ripening. Included in the data are the analysis for fat, salt and total solids of the fresh cheese and of the cheese at intervals during ripening.

The quality of the cheese was not influenced significantly by variations in the acidity during manufacture. In general, low acidities during manufacture favored fat hydrolysis and protein decomposition.

M42. Studies on the Ripening of Blue Cheese. C. B. LANE AND B. W. HAMMER, Iowa State College.

When cheese is made from homogenized milk there is commonly a definite rancidity developed during the manufacturing process. Rancidity becomes more pronounced as the ripening progresses; the green cheese may be very rancid before there is any conspicuous mold growth and when control cheese made from unhomogenized milk still shows no flavor suggesting fat hydrolysis. Some lots of cheese rather quickly show the odor of methyl n-amyl ketone and this may be so pronounced that it is objectionable. Eventually the rancidity and ketone flavors blend in with the flavors due to the higher fatty acids and a more desirable condition results. The possibility of the destruction of fatty acids through the activity of the mold must also be recognized.

A small amount of mold powder (0.01 per cent) was sufficient to produce satisfactory mold growth in blue cheese. The mixing of the powder into the curd immediately before hooping brought about a more uniform distribution of mold growth in the ripened cheese than when the usual method was employed in which the powder was sprinkled on layers of curd in the hoop; in addition, the former method prevented powder streaks in the cheese.

Cheese was made from raw and pasteurized skim milk to which boiled cream, raw cream or butter was added to obtain a fat percentage comparable to whole milk; the mixtures were homogenized under 2,500 pounds pressure at 90° F. Examinations during ripening indicated that the cheese made from raw skim milk plus the fat ingredients developed the flavor regularly obtained in young cheese made from homogenized, raw whole milk; the flavor developed rapidly in the cheese before any apparent mold growth. In comparison, the cheese made from pasteurized skim milk plus fat ingredients did not have a rancid flavor until the mold developed.

Small units of blue cheese, weighing about 2 pounds each, were made in special hoops. The cheese ripened satisfactorily although a longer period was generally required than with normal size cheese, due presumably to the tendency of the small units to dry out.

M43. The Influence of Steapsin on the Rate of Ripening Blue or American Roquefort Cheese. W. B. COMBS AND S. T. COULTER, University of Minnesota.

The work of Currie from which the author concludes that the characteristic peppery taste of Roquefort cheese is due to the hydrolysis of fat by lipase secreted by the mold *Penicillium roqueforti* is generally accepted. To develop a pronounced peppery flavor in Blue or American Roquefort requires from 7 to 9 months. In efforts to shorten the period required to develop the characteristic flavor, the authors have added varying amounts of either steapsin or castor bean lipase to milk intended for manufacture into Blue cheese. The resulting cheese developed a pronounced peppery flavor in 4.5 to 5 months. Though the flavor is not typical, it is relished by many. The cheese has proved of particular interest to those manufacturing cheese spreads since its flavor is so pronounced and less cheese is required to secure a trace of Roquefort flavor in the finished product.

M44. A Photomicrographic Study of Processed Cheese. HUGH L. TEMPLETON, University of Wisconsin.

From the appearance and behavior of experimental samples of processed cheese made with varying amounts of the emulsifying salts that are commonly used, it is evident that the salts must exert considerable influence upon the body and texture of the finished product. In an effort to study these differences microtome sections of the various samples have been prepared

and studied under a magnification of 230. The sections of cheese used were 20 microns in thickness and were stained with Sudan III to facilitate the identification of the fat. Photomicrographs were made of characteristic fields as viewed under the microscope. These pictures show that there are decided differences in the structure of the cheese and the distribution of the fat within the cheese.

For purposes of comparison photomicrographs are also presented of the cheese before it was processed, and in the case of two samples, portions of the cheese were removed at different stages of the processing operation. From these pictures it is evident that there are stages in the processing in which the fat in the cheese is to be found in rather large masses. These are broken up during the subsequent heating and agitation so that the fat in the finished product is usually found in a more finely divided form. In one case in which there was a marked fat separation during the heating, the fat in the final product occurred in large masses.

This method of study offers an excellent opportunity to investigate the solubility of the emulsifiers that are used. In the experimental samples studied, the salts were always added in a dry form at the start of the processing operation. In the case of the samples containing 2 and 3 per cent of Rochelle salt, microscopic crystals were very noticeable. These crystals might be either the undissolved Rochelle salt or calcium tartrate formed by the interaction of the emulsifier with the calcium of the cheese.

Pictures representing characteristic fields of commercial samples of processed cheese are also presented. These show variations in texture and fat globule size which are apparently related to the method in which the cheese was treated mechanically as well as to the salts that were used as emulsifiers.

M45. Influence of Manufacturing Methods upon the Acidity of Brick Cheese. D. W. SPICER AND WALTER V. PRICE, University of Wisconsin.

The effects of certain manufacturing practices upon the developed acidity of Brick cheese were studied experimentally using *S. lactis* for starter. Variations in amounts of starter, time of "ripening," temperatures of heating and times of dipping seem to indicate that excessive acidity in the finished cheese can be caused by either too little or too much acid development during curdmaking or by too slow or too rapid acid development before dipping. With milk of good quality, the best results followed making procedures so regulated that in a 2 hour lapse of time between cutting and dipping there was developed in the whey 0.02 per cent of titratable acidity.

M46. Relation Between Acid Defects and Hydrogen Ion Concentration in Brick Cheese. WALTER V. PRICE AND D. W. SPICER, University of Wisconsin.

The commercial value of Brick cheese is seriously reduced if graders can detect shortness in body or excessive acidity in the flavor. Flavor and body characteristics of approximately 70 lots of cheese were classified by the judges as sweet, slightly acid, sour and very sour. Measurements showed that the minimum pH was usually attained in 3 to 5 days after making. This minimum pH for each lot of cheese was closely related to the degree of acidity indicated by the criticism of the cheese judges. It was concluded that a minimum pH of 5.15 is excellent assurance that judges will not criticize Brick cheese for excessive acidity.

M47. Bound Water and its Relation to Dairy Products. H. PYENSON AND C. D. DAHLE, The Pennsylvania State College.

The cryoscopic method introduced by Newton and Gortner (Bot. Gaz. 74: 442, 1922) was used to determine the bound water content for this work. Determinations were made for acidity, alcohol stability, pH and viscosity. Following is a brief résumé of the results obtained:

The cryoscopic method can be readily used for the determination of bound water in liquid dairy products containing up to approximately 40 per cent solids.

Milk contains from 2.0 to 3.5 per cent of bound water, while buttermilk and skimmilk contain from 1.5 to 2.5 per cent of bound water. Cream contains about 0.15–0.19 gram of bound water per gram of solids. Colostrum milk containing 19 per cent total solids contains 4.65 per cent of bound water. The bound water of condensed milks vary with the total solids content.

It was found that milk containing 2.92 per cent of bound water after 24 hours aging at 40° F. has a distribution of its bound water content as follows: Casein 49.16 per cent, albumin 29.55 per cent, butterfat membrane 18.55 per cent, and serum minus albumin 2.74 per cent.

There is invariably an increase in bound water content upon aging at 40° F. In most cases along with this increase occurs an increase in the viscosity and protein stability. High heat treatment results in a decrease in bound water content, an increase in protein stability, and a decrease in viscosity. Short aging periods at relatively high temperatures give practically the same bound water content as longer aging periods at low temperatures.

Heat treatment above pasteurization temperatures decreases the bound water content of milk and dairy products. Even after aging at low temperature it never increases to the original unheated control.

Homogenization decreases the bound water content of ice cream mixes. As the pressure is increased there is an increase in the degree of fat clumping and a decrease in the protein stability and bound water present. Dual homogenization decreases the fat clumping, increases the bound water content and also increases the protein stability of the mix.

Increasing the pH toward neutrality and slight alkalinity decreases the bound water present. Decreasing the pH toward the isoelectric zone also

decreases the bound water content but to a greater degree than when the pH is increased.

The so-called milk protein stabilizing salts increase the bound water content and protein stability, while the destabilizing salts decrease the bound water content and protein stability.

The freezing of skimmilk causes an increase in the bound water content up to 85 days of storage at − 15° F. and then it gradually decreases in bound water. At 147 days the skimmilk appeared quite normal but watery. Frozen condensed skimmilk increases in bound water up to 25 days. At 57 days the proteins were partially cogulated so the bound water determination was not made.

The Hening and Dahlberg method of increasing the viscosity of sweet cream shows that when the cream is aged for 24 hours, an increase in the bound water content over ordinary pasteurized sweet cream results. Nevertheless, less bound water is found than in aged raw cream, although the viscosities were almost identical.

The fat globule membrane is hydrophilic in nature, binding about 0.6 gram of water per gram of solids. Pure milk phospholipids bind 6.0 grams of water per gram of phospholipid material. High pasteurization temperatures reduces the bound water content of the fat globule membrane and the milk phospholipids.

Creaming studies indicate that there is a decrease in cream volume and bound water content in whole milk when heated to high pasteurizing temperatures. Reconstituted milk made from heated 54 per cent cream and raw skimmilk gave a slight reduction in creaming and a reduction in bound water content while heated skimmilk mixed with raw cream gave a decided reduction in cream volume, and a normal reduction in bound water content.

Studies with raw and pasteurized milk made above and below the solidification point of the fat globules and with raw and pasteurized skimmilk indicate that the increase in specific gravity on standing (Rechnagel's phenomenon) is due partially to an increase in the hydration of the proteins and partially to the solidification of the fat globules and loss of carbon dioxide.

Gum arabic binds between 0.4 and 0.6 grams of water per gram of gum independent of the concentration and period of aging. Locust bean gum binds 1.93 grams of water and "Colace" 0.91 gram of water per gram of solids. Powdered egg yolk shows 0.92 gram of bound water per gram of egg yolk. Sodium alginate and gelatin give negative results.

M48. The Phosphatase Test for the Efficiency of Pasteurization. A. B. STORRS AND L. H. BURGWALD, Ohio State University.

Briefly, the basis of the phosphatase test is as follows: A small amount of milk is added to a substrate solution containing disodium phenyl phosphate and the mixture is incubated. The action of phosphatase, if present, upon this substrate results in the liberation of free phenol. The amount of phenol

liberated is then determined colorimetrically and serves as an estimate of the degree of heat destruction of the phosphatase, thereby indicating the efficiency of pasteurization.

In this investigation of the test the results obtained thus far indicate that the addition of as little as 0.2 per cent of raw milk to properly pasteurized milk, or underpasteurization by $1\frac{1}{2}$–$2°$ F., or a holding period of 20 minutes or less can be readily detected. It is possible that further modifications may improve the accuracy of the test in some respects.

The test has also been applied to milk pasteurized by the short-time high temperature method and although the data are not yet complete it appears that the test may be used quite satisfactorily on milk pasteurized by this method.

An investigation of the possible effects of mastitis milk on the accuracy of the test is also being carried on.

M49. The Significance of Ammonia in Milk: A Practical Method for Its Determination. A. E. PERKINS, Ohio Agricultural Exp. Station.

The ammonia content of milk has been a matter of interest and study for at least 80 years.

Formerly the ammonia found in milk was attributed mostly to contamination from the stable air or the chance introduction of impurities. It has since been shown, however, that even aseptically drawn fresh milk gives small but definite values for ammonia, averaging about .35 mg. per cent or 3.5 parts per million. These values are somewhat affected by the individuality and condition of the cow and possibly also by other factors. These points, however, have not been thoroughly studied.

By far the greatest source of ammonia in milk is the development of bacteria. The different species show marked differences in this respect and temperature plays an important rôle; but here again the subject has not been thoroughly studied.

Some of the methods which have been proposed for the determination of ammonia in milk are not reliable. Others which seem reliable make too great demands either in point of time or special equipment to permit their extensive use.

Proposed Method. 100 cc. of milk are placed in a flask with a graduation at 500 cc. 20 g. of dry or anhydrous $MgSO_4$ are added with shaking to assist in dissolving the salt. About 300 cc. of a good quality of 95 per cent alcohol are then added and the mixture thoroughly shaken. Alcohol is again added to the 500 cc. mark and the mixture is again well shaken. After standing for a few minutes the material is filtered through a paper filter.

200 cc. of the alcoholic filtrate as obtained above representing 40 cc. of milk are placed in a 500 cc. Kjeldahl flask with $\frac{1}{2}$–1 g. Magnesium Oxide.

125–150 cc. of the solution are distilled over in the regular Kjeldahl nitrogen apparatus, the end of the condenser or adapter being immersed in a measured amount of N/140 sulphuric acid. The surplus acid is titrated with N/140 ammonia, using a very dilute and carefully neutralized solution of methyl red as indicator. The blank due to reagents is practically zero, and recovery of ammonia added to the milk is about 90–95 per cent. The distillation is accomplished in about 10 minutes and a single sample may be carried throughout the process in about ½ hour. Doubtless micro equipment could be used to advantage, if available. Vacuum distillation has been tried and makes practically no difference in the results.

M50. The Application of Ritter's Test for the Detection of Copper in Milk and Dairy Products. JULES TURGEON, V. C. STEBNITZ AND H. H. SOMMER, Department of Dairy Industry, University of Wisconsin.

Ritter's test for copper contamination in milk, as originally reported, did not prescribe definite concentrations or amounts of the reagents to be used. It has been shown that the strength or amounts of the a-naphthol or the p-amino-dimethyl-analine sulphate had no effect upon the speed with which the color developed but the strength and amount of H_2O_2 greatly affected the rate of color change. The length of time required for the blue color to appear was decreased as the concentration of the H_2O_2 was increased. With the Ritter's test it was possible to detect added copper in milk with a concentration as low as 0.1 part per million. In general the time required for the color to appear was inversely proportional to the amount of copper contamination. However, this test cannot be used on different milks for determining the amount of copper present because the length of time required for the color to appear was found to be influenced by such factors as the age of the milk, the length of time in which the copper had been in contact with the milk, and the acidity. The addition of ascorbic acid to the milk containing added copper greatly retarded or prevented the development of a positive Ritter's test.

The milk from individual cows responded differently to the test when known amounts of copper were added. It appears that the susceptibility of the milk to oxidized flavor development affects the rate of color formation. Milks which readily developed a tallowy flavor when small amounts of copper were added also developed a blue color more quickly when subjected to the Ritter test than those milks which were more stable to oxidized flavor development even with larger amounts of added copper.

It appears that this test may be used not only for detecting copper contamination in a milk plant, but also the susceptibility of the milk from individual cows toward oxidized flavor development.

EXTENSION SECTION

E1. Conducting Organized Dairy Cattle Breeding Programs through Bull Associations. R. G. CONNELLY, Virginia Polytechnic Institute.

Organizing dairy cattle breeding is understood to mean the systematic mating of dairy cattle according to a definite longtime plan that will enable one to identify, trace, and analyze various genetic characters evident in populations of related dairy cattle. Any dairy cattle breeding program that permits the cumulative assembling of genetic data pertaining to cattle related by descent may be regarded from the genetic standpoint as an organized dairy cattle breeding program.

Major emphasis has been placed upon the herd sire in most organized breeding programs, and concurrently the measurement of genetic performance has been largely in terms of the production records of the daughters. Most sires being proved at present are owned by individuals. If these proved sires are the important avenue of approach in breeding up better strains of cattle, then some attention must be given to the perpetuation of the service and the blood of proved sires in enough cattle over a sufficient number of generations to permit the proper analysis and evaluation of the genetic traits existing in the family strains. The magnitude of such an undertaking bespeaks the need for cooperative breeding methods.

In the last analysis bull proving and the search for brood cow families should serve as important steps to a more comprehensive breeding program involving many more cattle than are now under observation. There should not only be a program of discovery such as our proved sire and brood cow investigations seem to be; but there should also be promulgated breeding programs by which superior inheritance discovered in individuals might be purified and concentrated in many cattle through intelligent matings. How such a program of genetic utilization can be developed among practical dairymen who are only now learning of the economic possibilities of dairy cattle breeding is a complex problem not yet solved.

The long time required to assemble dependable genetic information for a breeding program; the economic risk involved in dairy cattle breeding; the whimsical instability of men's reactions to the revelations of nature; and the lack of sufficient facts as well as standard fact finding methods are impediments in any comprehensive dairy cattle breeding program. Individually, dairymen strive to learn the genetic constitution of their cattle, but the earliest success and most lasting benefits are likely to be reserved for those men who breed large numbers of cattle and are able to perpetuate the lives of bulls and cows until their genetic influences can be analyzed and evaluated. This suggests the need for cooperative action among dairymen.

Cooperative bull associations, if properly organized, are replete with possibilities for individual dairymen who are not situated to keep more than one bull or who lack facilities for following the several methods of breeding—inbreeding, line breeding, multiple breeding to proved sires, etc.—to verify the purity of the inheritance of certain desirable characters and to perpetuate those characters in future generations. Where bulls are owned jointly, and the dairymen are of kindred minds and interests, bulls may be exchanged and proved with a minimum of risk to the individual dairyman. More comprehensive proof can be obtained on a bull if he is used in several cooperating herds and also when meritoriously proved bulls are discovered, they can be rotated among the several cooperating herds to recoup losses that will result when unsatisfactory bulls are proved. Furthermore, the female lines of related cattle can be studied to better advantage, and the heritable traits that determine productive ability, body conformation, and other physical characters can be concentrated in a large number of cattle in the least possible time if several dairymen are united under a cooperative breeding program.

Dairy cattle breeding programs conducted through cooperative bull associations lend themselves to better supervision from the state extension dairy husbandman and more nearly justify the talent and time required in the administration of a long-time dairy breeding project in the extension program. Finally, the possibilities of success when breeding up dairy cattle are likely to be greater if dairymen will merge their cattle breeding interests into a single program and develop the program as a cooperative dairy bull association. The benefits that may be expected from the cooperative treatment of so large a venture as progressive longtime dairy cattle breeding societies demonstrated by the signal accomplishments of cooperative breeding societies in Denmark, Holland and other countries.

E2. Dairy Sire Exchange Lists. WARREN GIFFORD, University of Missouri.

Any changes in the levels of producing abilities and other economic characters inherited by dairy cattle to higher levels that are under man's control will be brought about primarily by the systems of mating adopted and practiced in the individual herds, counties, states and country as a whole. Any progress in the improvement of the cattle population made by adoption of the Agricultural Extension Program or other educational movements must finally be measured by the average performance record of each successive generation of cattle produced within the group or population affected by such a program.

Selection seems to be the most powerful weapon for securing immediate improvements. Any Extension Program that actually brings about the production of more offspring from dairy animals of desired producing abilities than from inferior animals is a commendable project.

Dairy Sire Exchange Lists, which lists sires for sale, trade, or lease, are adopted and maintained as regular Dairy Extension Projects in 15 states of the 32 reporting as aids to breeders in securing sires for this improvement program. In 9 of these states these lists which give the owners of sires for exchange description and performance records of individuals, and the production information on·the immediate ancestors and terms of exchange such as price, et cetera, are state wide in scope. Seven states maintain County Wide lists for the various counties. Only 2 states report the listing of sires for sale from other states. All states maintaining this service send lists to their County Agents. Ten send them to Dairy Herd Improvement Association members or their testers. Two states send them to their breeder mailing list. Four states prepare these lists monthly, four semi-annually and one annually.

These sire exchange lists contain from 10 to 460 bulls and it was reported that a range of from 2 to 75 per cent, or an average of 33 per cent were exchanged.

Five states maintain county sire books and county sire exchanges. The county sire books contain complete information on all sires in the county and is used as a basis for exchange. The exchanges are supervised by a County Committee and the County Agent.

E3. Using D.H.I.A. Records in Conducting Dairy Cattle Breeding Programs. E. E. HEIZER, Ohio State University.

This paper presents a brief outline of the Dairy Herd Improvement Association Sire Program as approved by the American Dairy Science Association in 1936.

A discussion of the utilization and interpretation of records as an aid to the development of a constructive breeding program in D.H.I.A. herds is presented. A suggested procedure for use in herd analysis and a discussion of environmental and management factors of importance are included.

E5. A Feed Insurance Program with Trench Silos. V. L. GREGG, University of Arkansas.

Insurance of an adequate supply of cheap yet palatable feed is the backbone of a successful long-time dairy herd management program. Practically all other practices making up good herd management become bankrupt when the farm feed supply is cut short, forcing the herd owner to buy feeds, especially roughages, or sell part of the producing herd. Feed insurance when combined with other good farm and herd management practices is low cost production insurance to the dairyman.

Dependence upon regular pasture and feed crops supplemented by emergency pasture and feed crops has brought dairy herd bankruptcy to many dairymen in our state. This condition has been the result of widespread

droughts with resulting shortage of feed on the farm and high prices for purchased feeds. However, we should not condemn this system we have followed but we should supplement it with low cost stored feed for such years as we have experienced recently and will experience in the future.

These are the fundamental problems and conditions that commanded the attention of agricultural leaders in our state and in other states to adopt a campaign for the construction and use of the trench silo.

Although our trench silo campaign is young in Arkansas in comparison with those in some other states we have made rapid progress. Results indicate that the trench has an important place in dairy and livestock production. An expression from one county agent when asked if his trench silo demonstrators were satisfied with the results, best illustrates the response we are getting. He said his demonstrators were not merely ''satisfied'' but they were ''wild'' about the trench and were eager to tell all their neighbors and visitors about their results.

The campaign was started in our state by first locating about ten trench silos that had been built by farmers who read about the trench in farm papers and proceeded to build one with or without assistance from the county agent.

Winter feeding meetings were held at these trenches in 1935–36. These were district meetings where county agents brought leading dairy and livestock farmers to see the trench and learn construction, filling, and feeding methods. Printed subject matter was distributed at these meetings and newspaper stories were used as follow-up to draw attention to the new feed storage method.

Largely as a result of these district meetings fifty-six demonstrations in 26 new counties were established in 1936. The results were so conclusive and convincing for the man who visited one of the original demonstrations that little effort was needed to establish the demonstrations in new territory.

One of the main features of this campaign is to establish demonstrations where farmers can see them easily and then make every effort to draw attention to the demonstration. The results in one county bear out the objective of this approach. In 1934 one trench was constructed and used by the farmer but no particular attention was drawn to it, mainly because the county agent had another program which demanded all of his time. However, there were seven new trenches constructed by other farmers who happened to hear about it. Publicity on trench silos in general aroused their curiosity and they talked about them and after hearing about this one they visited it.

The county agent in this county started an active campaign in the fall of 1936 by holding feeding meetings at six of the eight demonstrations followed by local publicity on the features of the trench. During the following February another series of meetings was held to show results of the silos

and to discuss crops to plant for ensilage, construction, and methods of filling.

These meetings were followed by more publicity on the same subjects as were discussed at the meetings.

A county committee was then selected to map out a campaign procedure. The committee selected community captains to make a special study of the trench silo and its logical place on a dairy or livestock farm. Farm organizations, civic clubs, and creameries were also contacted to solicit their general support and assistance in the selection of captains.

These committeemen and captains have already reported 200 farmers who have definitely made plans to have a trench silo this fall. Most of them are planting a special ensilage crop (Atlas Sargo and sweet sorghums are preferred) and some are already digging their trench during time they cannot work with their crops and while the soil is more easily moved than it will be in late summer.

At least fifteen counties are carrying out a similar campaign and thirty-five others are carrying it on in a modified form, some just getting their first demonstrations this coming fall.

The use of the trench silo is being projected through all meetings and much of the publicity related to feed production, dairy and livestock feeding and management, pasture management, and the soil conservation program.

The place of the trench silo in feed production to provide safe low cost storage with feed insurance when a reserve is built up is very obvious. Also the economy and efficiency of ensilage as a feed is an old story with all of us. But to some, the place of the trench in a pasture development and soil conservation program may be a new departure.

One of the fundamental necessities for pasture development on most farms is controlled grazing. Ensilage on hand at all times makes controlled grazing possible. The project managers of our soil conservation service areas have recognized this point and are urging their cooperating farmers to build up a reserve supply of ensilage to be used to protect their labor and cash investment used in establishing pastures.

The trench silo has a place in the soil conservation if used as a means of supplying sufficient stored feed from half the acreage normally devoted to soil depleting feed crops. Also as previously illustrated, the trench silo makes it possible for farmers to establish pastures and maintain a fixed number of dairy cattle or other livestock instead of merely establishing pastures for the purpose of receiving diversion or soil conserving payments.

These are some of the points that are being presented to avoid any misconception that the trench silo is a passing fad or is only to be used in years of drought.

New methods, new farm and herd applications, and new soil type and drainage ideas gathered from the field demonstrations are being widely

broadcast. For example, we have found that the size may be small enough for four animal units including work animals, the ensilage crop need not be chopped at filling time, drainage is not necessary, flood waters or seepage cause very little damage and soil type or texture has little effect.

Thus far in our campaign we have found that to show a farmer a trench silo is only the first step in its establishment and proper use. Seeing is convincing but in this case too often only that feed will keep in the ground is the only lasting impression made and its full application to his own problems is overlooked. The feed insurance feature and its effect on the establishment of a permanent system of dairy and livestock development that will not go bankrupt in unfavorable seasons is to me the goal for us in trench silo work.

This all means considerable work in a campaign way to get immediate results and it necessitates follow-up work to show the farmer the value of having a one or more year's supply of feed stored to protect both his dairy herd and his established cropping system thus insuring more security of farm income.

E6.   An Extension Program in Dairy Cattle Feeding and Feed Crop Production.   K. L. TURK AND W T. CRANDALL, Cornell University.

Dairying predominates in the agriculture of the northeastern states, first, because most farmers can grow to the best advantage, pasture, hay, silage, and other forage crops for which there is regularly no satisfactory cash market; and second, because of the availability of metropolitan markets for milk.

Dairy farm profits depend largely on high yields of good quality feeds and the marketing of these feeds through good cows that are fully fed. Economical milk production, therefore, is concerned not alone with feeding sufficient amounts of the right kind of nutrients to good cows, but with furnishing as many as possible of these nutrients in home-grown roughages. A relatively small percentage of the land is adapted to grain crop production, therefore, much of the grain fed must be purchased.

Our program in New York has been built around these facts, and the fact that cows are underfed, particularly during the pasture season, and full use of roughage is not being made. Once the dairy farmer appreciates these facts, and most of them do when it is called to their attention, he will be interested in details of growing more and better quality roughage and in getting more total nutrients into his cows. Not only does it mean higher production per cow, but much of it comes from that roughage produced on his farm. Once the farmer is sold on the need for a change in feeding and feed crop production practices then the rest is easy.

In carrying out an educational program emphasizing a fuller use of roughage in supplying nutrients for milk production, it is obvious that a

close relationship with Agronomy must exist. The two departments are cooperating very closely in all phases of this program in New York.

Plan of Program. Since the old method of holding a feeding meeting here and there is not effective in reaching a very large number of dairymen, a more comprehensive program was inaugurated on a campaign basis in 1935. The following outline gives a brief description of teaching plan followed:

1. *Training school for county agents.*

   Counties are selected on the basis of submitted Farm Bureau work programs that list feeding as a major problem in the county. County agents from each of these counties come into the college once each year for a two-day training school. The agents have a definite part in planning details of the program and teaching methods to be followed.

2. *Farm surveys*

   To check up on feeding practices being followed, township or district surveys are made. Later surveys will show any changes in feeding practices.

3. *Service letters*

   In order to reach a larger number of farmers and to furnish timely information that cannot be given in meetings, printed service letters have been effectively used in this program. These service letters are prepared by Animal Husbandry and Agronomy specialists. Dairymen in the counties are given a chance to sign up for these letters which are mailed to them each month.

4. *Two-day feeding schools*

   A two-day feeding school is held in each county. Also, several counties have held two-day Agronomy schools. In counties that have held both types of schools, combination Agronomy and feeding schools are held. Follow-up regional and county discussion type meetings are very valuable following the county-wide meetings.

5. *Demonstration farms*

   Demonstrational dairy farms are established in cooperating counties on which recommended practices of feeding and of feed crop production will be followed. These practices will show the relationship between efficient production of high quality feeds and farm returns from good cows well fed and managed. Farms selected are those that have possibilities for forage crop and pasture production which are not being fully used at present. However, these farms have herds that are free from disease, have inherited ability for high production and are being tested in D. H. I. Associations. Each farm is visited by Agronomy and Animal Husbandry specialists at least twice a year to collect records and make recommendations.

6. *Publicity*

Timely news articles on feeding for Farm Bureau News and county and local press are furnished the county agents at regular intervals.

7. *Analysis of D. H. I. A. records from feeding standpoint*

An analysis of feed records of members of dairy herd improvement associations is made each year. Many of the associations hold yearly summary meetings where their feeding records are discussed.

8. *Dairy tours—field days*

Dairy tours are held in each of the cooperating counties. In the future these tours will feature the demonstration farms.

9. *Exhibits*

Feeding exhibits are arranged at county fairs and also at the state fair.

Through all these teaching methods a few simple practices are continually stressed. As they apply these feeding practices, more dairymen will develop the resources of their farms for the greatest economical production of nutrients. This will reduce their dependence on purchased nutrients in grain and they can realize the greatest possible returns on the home-grown feeds by selling (feeding) them to good cows of high producing ability.

E7. Establishing and Conducting a Dairy Pasture Improvement Program in Missouri. M. J. REGAN, University of Missouri.

The pasture problem in Missouri presented itself as a State wide problem of making Missouri dairymen pasture conscious. In attempting to work out a Dairy Pasture Program it became evident that there were three distinct phases, that of establishing a pasture program, preparing the necessary equipment and conducting the program in the field.

Establishing the Program. In establishing the Dairy Pasture Program it was necessary to determine the need for such a program in order to know the size and scope of the problem. It was determined in Missouri that approximately 40 per cent of the land is in pasture and that less than 1 per cent of attention paid to this important problem. This land, for the most part, is sub-marginal and to some extent is land that has become unprofitable for cultivated crops. Our second problem was to set up the needs within the program such as seasonal pasture and land fertility requirements. A good soils system and a poor soils system of farming was established. The supply of natural pasture by seasons was determined and seasonal supplementary pasture recommendations worked out. It was also necessary to bring out the economic importance of the problem and the amount of work accomplished up to date. This included slope of the land, soil losses, fertility

losses, water holding capacity of soil and their relationship to the time the land is covered. Showing in addition the labor saved and the economy and efficiency of production. At attempt was then made to set up an all inclusive State wide system.

The State wide program was then given a name or slogan that would attract attention and invite criticism. This was first given the name of the "Year-Round Dairy Pasture Program," and was later changed to the "All-Year Pasture System." Close cooperation has been maintained with the Soils and Crops Department. Through the help of this Department the system of single field rotations was worked out, gradually the Crops Department took over the entire responsibility for pasture development in Missouri.

Equipment Needed. After successfully demonstrating individual pasture practices it became apparent that the entire system needed to be presented to the field. Charts, circular letters, news articles, method and result demonstration blanks, bulletins, circulars, radio talks and exhibit material were developed to fill this need.

Conducting the Program in the Field. In taking the program to the field result demonstrations were established to show, by example, the practical application of this system and to prove to the community that this system is in no sense experimental. The establishment of these demonstrations allow the Extension worker to utilize the result secured to prove, by comparison, the value of this system. It was then recommended that the County Extension Agents adopt this as a project in their Program of Work. Community meetings were held and all of the publicity methods above mentioned were utilized. A gradual attempt is now being made to move from individual pasture systems to a pasture consciousness, feeling that progress will tend to bring sub-marginal lands into the marginal class, increase the average number of animal units carried on the farm from eleven to at least twenty, reduce cost and increase the efficiency of meat and milk production and move toward a less rigid, a freer and more abundant farm life.

E8. A new Method of Conducting a Feed Meeting. J. G. HAYS, Michigan State College.

A new method of discussing the problem of low-cost feeding has been successfully used in Michigan.

The method is new in that a slated (or "blackboard") flexible chart is used, on which local feed prices are chalked in; a feeding value for each feed is assigned through the use of a new table called "Evaluation of Dairy Cattle Feeds"; and comparison of feeding value with local price for each feed shows whether such feed is too costly, worth the money, or a bargain.

Interest on the part of the crowd is easily sustained because this method of presentation employs the value of suspense and of surprise.

EVALUATION OF DAIRY CATTLE FEEDS

Michigan State College   Dairy Extension (1937)

Feed values for roughages are by the ton; all other feeds by the hundredweight.

44% Cottonseed
40% Gluten Meal
| 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 | 2.75 |

41% Commercial Feeds
| | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 | 2.75 |

44% Soy Bean Oil Meal
41% Cottonseed
| 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 | 2.75 |
| 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 |

37% Linseed
Dried Brewers' Grains
32% Commercial Feeds
34% Linseed
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.50	0.75	1.00	1.25	1.50	1.75
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50

Directions: Considering local prices, select a high protein feed and a cereal feed
that seem cheapest. Place a straight-edge so that it rests on these
selected base feed prices. Comparative values of all feeds will be
shown at points where straight-edge intersects lines for such feeds.
Values for "commercial" feeds - because of variation in their compo-
sition - cannot be so accurately determined as for other feeds.

Soy Beans
| 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 | 2.75 | 3.00 |

"Cull" Beans
| 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 |

Alfalfa Hay or Soy
or sweet clover
| 5.00 | 10.00 | 15.00 | 20.00 | 25.00 |

Gluten Feed
24% Commercial Feeds
Wet Brewers' Grains
(40# = 1 bu.)
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
cwt. 0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
bu. 0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.20

Flour Middlings
Peas
20% Commercial Feeds
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50

16% Commercial (Fiber 15+)
Bran
Middlings
Oat and Pea Hay
16% Commercial (Fiber 10-)
Flax Seed
0.50	0.75	1.00	1.25	1.50	1.75	2.00
0.50	0.75	1.00	1.25	1.50	1.75
0.50	0.75	1.00	1.25	1.50	1.75	2.00
5.00	10.00	15.00	20.00	25.00
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25
0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25

Red Clover Hay
Rye Middlings
| 5.00 | 10.00 | 15.00 | 20.00 | 25.00 |
| 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 |

Oa
Ba
| 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 |
| 5.00 | 10.00 | 15.00 |

Rye
Barley or Wheat
Mangels
Mixed Hay or Pea Hay
Corn Fodder
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
1.00	2.00	3.00	4.00
5.00	10.00	15.00	20.00
5.00	10.00	15.00

Timothy Hay
| 5.00 | 10.00 | 15.00 | 20.00 |

Corn (#2)
Corn and Cob Meal
Corn Stover
Corn Silage or Potatoes
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00

Feeding values

DP	NON DP		$ PER CWT	LOCAL PRICE	¢ SAVE	DP	NON DP		$ PER 10%	LOCAL PRICE	$ SAVE
7	73+	Corn No 2)				10+	31	Alfalfa Hay			
6	70	Corn and Cob				10+	31	Sw. Clr. "			
9+	62	Oats				11	31	Soy Bean "			
10	70	Rye				9	36	Pea Oat "			
9+	69+	Barley				7	36	Red Clr. "			
11	72+	Wheat				4	34	Mixed "			
35+	40+	43% Cottonseed				3	34	Timothy "			
34	39+	41% "				3+	32	Corn Fodder			
36	45	43% Soy Bean O.M.				2	22	Corn Stover			
33	54	Soy Beans				3	20	Bean Pods			
36+	45+	41–43% Gluten Meal				1	20	Oat Straw Barley			
33+	44+	37% Linseed				1	10	Wheat Straw Rye			
30+	47+	34% "				1	12	Corn Silage			
22+	54+	Gluten Feed						Potatoes			
21+	87+	Flaxseed						Roots			
20+	30	Dd. Brewer's Grains		●		3+	12	Alfalfa Silage			
20	55+	Beans									
20	59+	Peas									
13	57	Rye Midds									
15	60	Flour Midds									
14+	57+	Std. Midds									
13	53+	Std. Bran									
5	67	Dd. Beet Pulp									
4+	11	Wet Brewer's Grains									
1	55+	Cane Molasses									
2+	56+	Beet									
(Estimated)		Commercial Mixed									
35	45	41%									
30	45	32%									
21	55	24%									
18	55	20%									
14	55	16% (Fiber 10% –)									
15	50	16% (Fiber 15% +)									

The chart. For ease in transportation the chart is made of slated cloth. (Size 52 × 60 inches.) The data shown below are permanently painted on the chart. Values for digestible protein throughout are taken from the new edition of Morrison's "Feeds and Feeding." Values for digestible non-protein follow Morrison excepting for roughages and for concentrates high in fiber. Here values follow Huffman of Michigan. All values are quoted to the nearest half pound, the mark + indicating five tenths.

The table "Evaluation of Dairy Cattle Feeds" was worked out after the method devised by Petersen of Minnesota. With a known price for a local feed high in protein and for one low in protein, the comparative feeding values for all feeds on the table can be quickly found, expressed in dollars and cents.

Meeting procedure. The most effective use of the chart is to have the column headed "Local Price" filled in before meeting starts. Reliable figures can best be obtained from a feed-dealer or D.H.I.A. tester. (Farmers' figures vary, depending on when and where they purchased.)

Next taking each feed in turn discuss its make-up from the columns headed "D.P." and "Non D.P."; point out any special properties as palatability, laxativeness, local availability, and finally from the table "Evaluation of Dairy Cattle Feeds" chalk in the feeding value in column headed "$ Per Cwt" (or "$ per Ton"). This figure is what the crowd has been waiting for. Its appearance settles whether the local price on the feed under discussion rates the feed as costly, worth the money, or a bargain.

Throughout the meeting constant stress is laid on the point that no feed can be correctly evaluated unless it forms part of a properly balanced ration. Warning is given that no feed should be introduced into a ration just because the feed is locally low priced; the feed must fit into the feeding system. Systems of feeding are therefore discussed.

Which combination of roughages and of grains will produce milk at lowest cost? Each farmer is provided with two documents to help him easily figure this out for himself—a sheet showing balanced rations, and the sheet, "Evaluation of Dairy Cattle Feeds."

E9. Subsidizing Testing from the State Office. J. W. LINN, Kansas State College.

Unlike some other countries, in the United States the organization and financing of dairy herd improvement associations has been considered to be the local dairymen's problem. The adoption of rules and regulations laid down by the Bureau of Dairy Industry, United States Department of Agriculture, has been at the option of the various states. Within recent years, the states have almost universally accepted this uniform program.

The financing of dairy herd improvement associations has been one of the major problems in their organization and maintenance.

The facts presented in this paper are the result of a questionnaire sent out to every state in the union for the purpose of studying this problem. Forty-one replies were secured, eight of which indicated some central office financial assistance to dairy herd improvement associations. Two of these might be considered as subsidization, the other six more as payment for extra service on the part of the tester.

Not until 1923, when the state of West Virginia began paying twenty dollars a month from the state appropriated funds, was any effort made to assist the local dairymen in the problem of financing their association. The policy of paying supplemental money to testers is now in effect in five other states. In every case, the money given is for additional services rendered.

In Kansas and Mississippi the testers are listed as assistant county agents in order to be eligible for these funds. When the Kansas Extension Service's federal funds are audited, it is possible for the auditor to tell where every cent has been used and the financial relationship of every association member.

Some of the advantages secured by furnishing financial assistance to the dairy herd improvement association may be summarized as follows:

1. Added service, such·as assisting with farm management work, is made possible.

2. Better testers can be secured.

3. Tester is definitely linked with Extension Service.

Some of the disadvantages to this program are:

1. More work is added to the already heavy schedule for testers.

2. The added work is forcing a change in methods of keeping feed records on individual cows.

3. Adds work at the State Extension office.

Extension Services have taken a definite step forward in assisting with the financing of dairy herd improvement associations. The program has been improved by the addition of other services, securing better testers, and making the plan a part of the Extension program. The plan will be more permanent where a definte financial accounting system is used.

E10. Subject Matter Included in Testers' Training Courses. FLOYD J. ARNOLD, *Iowa* State College, Ames.

The knowledge which cow testers must have in order to develop all phases of Dairy Herd Improvement Association work, makes specially designed training courses necessary. In addition to knowing the daily routine of keeping accurate production and feed records, the properly trained tester, is familiar with uniform rules and regulations governing D.H.I.A. work; understands the National plan for "Herd Identification and the recording of Production records"; is able to analyze records to show influence of sires or foundation cows, etc. In most states, Herd Improvement Registry test-

ing is handled through the Dairy Herd Improvement Association and to do this work the tester must be familiar with the breed rules.

The need for testers to fill vacancies is unusually large due principally to the nature of the work. Many testers because of their education and training have opportunity to step into jobs which pay a higher salary and are more desirable. During 1935 and 1936 in Iowa a total of 50 inexperienced testers were placed. These men were all high school graduates and half of them (25) had college or short course training.

To determine the amount and kind of training required of testers in different states a questionnaire was sent to all Dairy Herd Improvement Association supervisors. The information received on these questionnaires indicates that the amount of training testers get varies from nothing but instruction in handling the records to a three months' course in College. To a large extent training courses are taught by Extension Dairymen.

Some of the topics included in Testers' Training Courses are:
(1) A general summary of Dairy Herd Improvement Association Work.
(2) Steps in Organization and Reorganization of Associations
(3) Importance of Uniform Rules and Regulations
(4) Procedure in Compiling Herd Record Books
(5) Summarizing the Herd and Association Records
(6) Sire Improvement Program
(7) Recording the Identity and Production Performance Permanently
(8) Compiling Permanent Herd Records
(9) Herd Improvement Registry Testing
(10) Association Activities

The method of training testers should include actual practice. The use of information and technique rather than merely giving subject-matter courses to familiarize testers with organization and state set-up.

E11. Getting Permanent Records Filled Out for Dairy Herd Improvement Association Members. C. R. GEARHART, Pennsylvania State College.

Permanent records as used in this topic refer to records kept on a special sheet designated an BDI–1057 which was made available through the Bureau of Dairying, Washington, D. C., in 1936. This special record sheet is often referred to as the Life History Sheet of a cow.

For years Dairy Herd Improvement Association records have been compiled by testers and recorded in the members' herd books. The detailed information kept in these books together with the totals and summary at the end of the year are essential in a good dairy herd record keeping program. In most herds, however, the herd book for each calendar or association year provide the only permanent record of the production, reproduction and other data on each cow in the herd. Many dairymen have continuous records

on their herds over a long period of years. This means that the records of each individual cow are in as many herd books as the number of years the cow was on test. The complete record of a cow in the milking herd for 10, years can only be found through a study of 10 herd books. This takes time and is inconvenient and as a result the lifetime records and history of an individual cow are seldom known. Lifetime records are very important however, in a constructive herd improvement program.

The permanent record, or life history sheet as it is called, is designed to show the lifetime performance of a cow on a single sheet.

The value and wide useful application of the information on the life history sheet is beyond the average testers' and dairymens' vision. Some of the uses to which the sheet can be put are:

I. It makes it possible to examine the lifetime performance of a cow without looking through a number of herd books, forgetting what was in the first books as you hunt for the record in the last books.

II. The daughter's records can be compared with those of her dam by simply bringing together the two life history sheets.

III. The records of dams and daughters at various ages can be compared, such as the two-year-old record of the dam and the two-year-old record of her daughter.

IV. To study the result of the use of various sires in the herd the life history sheets of all daughters of each sire can be sorted out and brought together in groups. This makes sire comparison an easier matter.

V. The influence of foundation cows in the herd can be studied by bringing together the records of such cows and their progeny through the several generations. Often such a study reveals foundation cows whose superior type and production qualities have persisted through several generations.

VI. The sheets provide an easy way of getting information for sales, for pedigrees and for proving sires.

VII. A glance at the life history sheet of an animal will show her lifetime breeding history.

The discussion at the American Dairy Science meeting will center around method involved and the success and difficulties encountered in getting the life history sheets made out and kept up to date as disclosed by replies to a questionnaire which has been submitted to the various states.

E12. What Can Be Eliminated from the Tester's Work To Make Possible Newer Developments. A. B. NYSTROM, Bureau of Dairy Industry, U. S. Department of Agriculture.

The work of a tester is sure to change from year to year as the interests of the members change and as the tester himself sees the need for taking on new tasks. Within recent years the various extension workers, particularly county agents and State extension dairymen, have likewise demanded extra

work of the testers, all of which is aimed at more effective results from D.H.I.A. work to the ultimate benefit to the producer or member of such associations.

Just how much work a tester can do is largely a matter of individual ability. Differences in testers are as inevitable as differences in other classes of workers. Therefore, if nothing is said about his duties the tester will make his own decisions as to what to eliminate, to the possible detriment of the ultimate result of the whole project. What the tester needs and would welcome is some sound advice from his county agent and the State extension dairyman as to what could be eliminated; and in order that these advisers may give sound counsel, it was thought desirable to discuss the matter thoroughly before the Extension Section of the American Dairy Science Association, and to broadcast the results of these deliberations among those interested.

In order to get an expression from all of the States on this topic, the writer made a survey by means of a questionnaire that included a list of 16 duties which might be considered for elimination. Included in the questionnaire was a request that other duties not in the list be added where possible.

A few of the duties included in the questionnaire were: Weigh and record the roughage fed to each cow each visit; same for concentrates; report individual feed records on each cow each visit; report daughter-dam comparisons on BDIM–672; test samples of skim milk for herd owners; make outline of markings of each animal on test; fill out BDI–46 for each cow; fill out BDI–46 for herd totals only; and fill out Life History sheets (BDI–1057–58) for all animals tested.

The final results of the survey were to be presented in full at the June Meeting at Lincoln. An attempt was to be made to show clearly which of the testers' duties must be continued if the tabulations made by the State and by the Bureau of Dairy Industry are to continue; likewise which may safely be dropped without impairing the effectiveness of the work.

That there is considerable interest in this subject is shown by the fact that up to April 26 replies had been received from 35 or nearly 77 per cent of the 46 States queried. In nearly every case also, comments were received by letter and some very pertinent suggestions were included. Replies received up to April 26 indicated that some of the duties listed were clearly voted out, while others could be eliminated in some States, but not in all.

E13. Uniform Rules Governing the Operation of Dairy Herd Improvement Association. FLOYD JOHNSTON, Iowa State College.

Dairy Herd-Improvement Association testing in the United States is again growing rapidly and should continue. Although the more important value of association records is a guide to the dairyman himself, more and more emphasis is being placed on the advertising value. It will probably

continue that way. Publicity given records will keep many dairymen from testing because of the inherent desire to keep from their neighbors information about their cows.

With the widespread recognition and general acceptance of the identification and permanent record program it seems obvious that rules governing dairy herd-improvement association testing should be strengthened to insure public confidence. Such rules must be lenient enough to encourage more testing and be practical enough to be administered. Any regulations formulated should, (1) insure accuracy, (2) be enforceable, and (3) not discourage testing.

It is simple enough to set up rules that will fullfil the first requirement, but not so with the second and third.

Some of the people interested in records would like the rules governing dairy herd-improvement associations as strict, if not even more so, than the rules now governing the breed herd tests. Others seem to want essentially no rules at all. There must be a "middle course" that will insure reliability and yet that can be enforced.

To determine the desire of the states concerned a questionnaire with tentative rules was submitted to all state supervisors of dairy herd-improvement associations, superintendents of testing of the breed associations and officials at Washington, D. C. A set of regulations will be prepared from a summary of questionnaires returned. They will be submitted for consideration at the Extension Section meeting in June at Lincoln.

E14. Dairy Herd Improvement Association Publicity. E. C. SCHEIDENHELM, Michigan State College.

The problem of carrying on a publicity program for dairy herd improvement association work has always been one that provoked considerable discussion by dairy extension men. It has been known that it is desirable to have an effective publicity program. Just how this program should be handled and developed is the question again at hand. To approach the problem is seemed advisable to divide the discussion into two separate divisions. The first dealing with publicity as it is developed locally in the county or association area, and the second from the standpoint of the dairy extension office on a state wide basis.

It is generally recognized that publicity in the county or local area can be divided into two divisions, one dealing with records, and the other with desirable dairy practices. Dissemination of publicity material from the central dairy extension office is one that can be confined largely to informing the testers, county agents, and members of the progress of the work.

To get a picture of the attitude on this problem from a national viewpoint, questionnaires were sent to all the state dairy extension offices. At the time of this writing statistics are available from twenty-seven states, of which

twenty-six gave replies. One state has only a few herds on test and consequently is doing very little in a publicity way. The twenty-six states reported included 78.6 per cent of all the associations operating in the United States on January 1, 1937.

Publicity within the county is probably the most effective from the standpoint of keeping up the interest in each association. People naturally like to hear about people and practices that are close to them or those whom they know. Twenty-five of the twenty-six states reported encourage local publicity. It is interesting to note that in Wisconsin the state office does not encourage local publicity. This is left to judgment of the county agents in counties in which the associations operate.

In the mind of the author more of the publicity within the association area should be devoted to desirable dairy practices used and the influence they have than to the use of large numbers of high cow and high herd information. Results from the use of desirable practices can be expressed in increased returns in dollars. After all, we are trying to improve the farm income of our dairymen. We know that herds of a certain level of production are more profitable than those below this level. However, I believe many agree that if we can talk more about increased returns than about high production we can accomplish more good by doing so. Five states of the twenty-six already limit publicity to practices only. Many more say this should be done.

Apparently a majority of the states are attempting to get some type of report on association activity back to the members monthly. Only two states out of the twenty-six reported do not send back to the members a summary of the yearly report to at least a majority of their associations.

Abut sixty per cent of the states discourage high cow publicity. Idaho has a method which could be adopted profitably by other states. This is called the "high-low" cow publicity. The purpose is to encourage a uniformity in the cows' production in a herd, rather than a few extremely high cows, some of medium production and others quite low from a production standpoint, all are of a more uniform production level.

Whether publishing feed cost information gives the public the wrong impression as to total production costs received about a fifty-fifty vote, with a slight edge in favor of those saying that it does.

There is an indication that many states are definitely turning to more publicity on lifetime records on cows. Many states not doing so at the present time say it is a good idea. No doubt with the permanent herd books coming into use this type of publicity will be used quite extensively in many states in the future. It will be a turn in the right direction.

The question of how publicity should be handled from the state office is one largely resolving itself into how many channels are available and which of those available are most effective. All but one state reported issues a

state summary each month. Pennsylvania does not, however one will find that this state held up on association numbers as well or better than any other during the depression years. This state sets up a seasonal publicity campaign through the testers on desirable practices. This again raises the question, is it not more desirable to encourage profitable practices. After surveying many of the monthly newsletters published in the various states one finds a great wealth of information dealing with practices. Possibly it would be just as well to confine the monthly newsletter largely to this material. Michigan does this to a large degree, state association information is summarized by districts with no mention made as to association names, herd owner's name, or name of owner of high cows.

With reference to the "latitude and longitude" of the persons reached through the state newsletters one finds considerable variation. Policies set up by state extension directors and the amounts of funds available for this material are probably two factors playing an important role. Only ten of the twenty-six states include Smith-Hughes instructors of their D. H. I. A. newsletter list. Probably many of us are missing a splendid opportunity to inform many "future farmers" about the value of the D. H. I. A. program.

In most states the important dailies, weekly or monthly farm magazines are used to publish stories on D. H. I. A. activities. Probably another good avenue for this publicity would be through the "house organ" of many of our cooperative creameries and cooperative milk associations. Many of the members of these organizations should be good D. H. I. A. prospects.

E15. Methods of Financing 4-H Dairy Calf Club Members. JAS. W. LINN, Kansas State College.

Extension dairymen realize that of all the 4-H Club projects, the dairy calf club is the most difficult to finance. The reason for this is that: First, purebred dairy calves cost more than other club animals; second, the project covers a three-year period; third, the returns necessary for retirement of the original investment cannot be obtained before the third year; and fourth, the risk is greater because of the cost and length of the project, and the fact that usually only one animal is involved.

The problem of finance is easily cared for when the club member has sufficient means or when a calf can be secured from the parent's herd. In most cases, however, the calf must be purchased, and in many cases the financing must also be arranged outside the home.

To become familiar with the methods used throughout the United States a questionnaire was sent to every state. Reports from 19 of the states indicate that finances from the home and local bank have been adequate to meet the need, while the 19 other states report one or more additional methods of financing club members have been used. Besides being financed at home or by the local bank, the other three principal methods are: First, civic clubs,

chambers of commerce, or members of these organizations; second, National Production Credit Associations; and third, breeders selling on a note or contract. Also in some states money is furnished by state breed associations, farm bureaus, state dairymen's associations, and a junior breeders' fund.

Because of the comparatively large financial risk, it is essential that some type of insurance be carried wherever money has been borrowed. This might be carried either cooperatively or from some insurance company.

Three states recommend that other projects with a quicker cash return be carried with the dairy project to assist in paying for the calf. Two states recommend the use of one-half the milk or cream check for the retirement of the note. Two states suggest the purchasing of bred yearlings in order that some return may be secured during the first year. Three states recommend a definite schedule of payments.

Since proper financing and insuring are fundamental in any program, further study should be made and reported to this group.

E16. Applying the Danish System of Judging to Dairy 4-H Club Work.
D. M. Seath, Kansas State College, and G. M. Harris, University of Kentucky.

Before deciding upon how well the Danish plan would serve American 4-H Dairy Club shows one should first consider some of the features of the Danish system. As practiced in Denmark in the open classifications, the system includes some of the following distinctive features:

1. Each Danish herd is entitled to show in its own district only. Prior to the district show, however, it can be shown at its local show. Because of this limitation there is no show circuit arrangement.

2. Every animal coming to the show is classified. The entries in the class are first lined up individually then the class is usually divided into four (sometimes five) groups and distinctive display cards are awarded to the owners who must display them above their animals at the fair.

3. To make the final cash awards consideration is given in some shows to the pedigree of the animal which includes the show ring and lifetime production records of its ancestors. The universal adoption of the Danish plan for placing 4-H Club calves in the United States would have the following advantages.

1. The classification feature would help avoid many hair-splitting decisions and would help prevent certain reversals of placings at later fairs.

2. It would help establish more definite ideas pertaining to grades of perfection in dairy 4-H Club work. It could serve in this connection with type alone, or if also applied to ancestry records, etc., it could do likewise for pedigree judging.

3. The system could make it easier to handle large classes, and would send each club member home with a more definite idea of the relative merits of his exhibit.

4. It would reduce the glory going to the top place winner and let others falling into the first group share some of it.

5. Judges could omit awarding first group awards where quality is poor or reduce its size to show relative merits of exhibits.

6. A more equitable distribution of money could be effected with prize money more nearly serving its true purpose; namely, paying the necessary expenses of getting animals to and from the show.

In spite of the many possible advantages that might accrue from the adoption of the system there would likewise be certain difficulties encountered. Among them are:

1. The plan would not be too adaptive to small club shows. With small classes it would be hard to find representative classification groups.

2. One of the most serious problems would be to keep uniform grades in the minds of the public. Judges would vary in their ideas, and it would require frequent judging conferences to keep their classifications consistent.

3. More ribbons would be required, thus making the plan slightly more expensive than our present one.

4. Our conventional type of show has contributed much toward our 4-H Dairy program and many will hesitate to support a change.

Reports from state 4-H Club leaders and certain dairy specialists indicate that many are ready for the adoption of some such plan as the Danish one in the placing of livestock exhibits. In fact State 4-H leaders have already adopted some such classification plan for all of the exhibits except livestock at the International Livestock Exposition where they hold their national 4-H Club congress annually.

Livestock shows have already, at various places, used this system of placing their animals. At least one State 4-H Club show used it during 1936. Various states have tried it in connection with their spring parish shows. The Wisconsin Dairymen's Association sponsored a group of dairy shows in 1936 where this system was used exclusively. In all these cases, and many more that will be reported upon at the Association meeting, the system has been found to be satisfactory on a whole. Most objections found have been listed above. In most cases with slight changes these have been or can be altered in order to give more satisfactory results.

E17. 4-H Club Demonstrations for Improvement of Quality. E. A. GAUNTT, New Jersey College of Agriculture.

In New Jersey the dairy farmer is faced with high taxes, high labor costs, high land values as well as high feed costs. In order to stay in the dairy business it is necessary for him to produce only the highest quality of milk possible. Although the New Jersey State and local Boards of Health requirements are high it is necessary for the New Jersey farmer to more than meet the requirements if he is to keep his rightful place in the metropolitan New York and Philadelphia markets.

The extension service long ago realized that it had a job to do. 4-H club work seemed to offer one of the best opportunities to further this program of helping the farmer to produce a high quality milk. Demonstration teams were organized and trained to show how clean milk is produced. These appeared before Granges and other farm groups. Then a film strip was made up by J. B. Parker of the U.S.D.A. with the aid of one of the extension dairymen in New Jersey.

This film strip outlines the value of milk to the human race and the procedure in setting up a quality milk club. In this club the members are taught how to wash and sterilize utensils and how to clip udders and flanks. They are taught the use of the strip cup, proper cooling and methods of testing the quality of milk. They score dairy barns, and learn how milk should be handled from the time it leaves the cow until it reaches the consumer.

This educational method has helped tremendously in improving the quality of milk produced not only in the herds where there are 4-H club members but in many herds throughout the state.

E18. A Quality Improvement Project for Milk and Cream. C. J. BAB-COCK, Bureau of Dairy Industry.

The quality of a dairy product depends primarily upon the quality of the raw product from which it is made. To improve the quality of dairy products it therefore becomes necessary to improve the quality of the milk and cream from which they are made. A quality improvement project that is applicable to all dairy products is submitted.

The duties of each of the agencies which should cooperate in carrying out this project are outlined as follows:

Extension Service. (1) Assume active leadership of the project. (2) Obtain the cooperation of all interested agencies. (3) Supply subject-matter material to all county agricultural agents and other concerned. (4) Prepare and distribute to producers of milk and cream information matter dealing with the care of milk and cream on the farm en route to market. (5) Prepare and disseminate, through all available channels, information matter pertinent to this program. (6) Advise dealers and manufacturers as to the tests which they should use for determining quality. Instruct dealers and manufacturers how to conduct and interpret such tests. (7) Get in touch, at the earliest possible moment, with all producers whose milk or cream is of poor quality, as shown by the tests for quality. (8) Advise dealers and manufacturers as to the grading system best adapted to their particular product. (9) Make frequent check on plant operators to see that they are properly conducting the tests for quality and properly grading the milk or cream received. (10) Make frequent check on dealers and manufacturers to ascertain that they are handling and processing their products according to the best known methods. (11) Stimulate and keep up interest.

State Control Officials. (1) Cooperate with the extension service by informing them of the work they are doing. (2) Acquaint all local health authorities with the need, purpose, and scope of this program and enlist their cooperation, particularly in aiding dealers and manufacturers with grading milk and cream, condemnation of low-quality products, and farm inspection. (3) Make frequent inspections of all cooperating plants to see that they are complying with all sanitary regulations. (4) Cooperate with the extension service in checking plant operators to see that they are properly conducting the tests for quality and properly grading the milk or cream received.

Vocational Agriculture. The Board of Vocational Education will take the proper steps to bring this program and its full import to the attention of all teachers of agriculture in the schools of the State and will instruct them to make the teaching of proper care in the handling of milk and cream on the farm, and the stressing of the same, an integral part of their educational work.

Producers Cooperatives. In those areas where there are producers cooperatives their field men should have access to the results of the quality tests in order that they may devote a greater portion of their efforts to aiding the producers of poor quality products.

Dealers and Manufacturers. (1) Conduct tests for determining quality. (2) Furnish results of quality tests to the extension service. (3) Adopt a grading system or at least reject all milk and cream of low quality as shown by the quality tests. (4) Call meetings of producers at direction of extension service. (5) Follow up work with their poor quality producers when possible.

INSTRUCTIONAL SECTION

I1. Trends in Dairy Instruction. C. E. WYLIE, University of Tennessee.

As dairy conditions change on farms and in industry, in addition to the discovery of new processes, equipment, and methods, it is important that methods and materials used in teaching be revised from time to time. The purpose of this study is to present some phases of the dairy instructional work in the Land Grant Colleges together with some trends in instruction. This includes the following:

1. Collegiate and non-collegiate courses.
2. Methods, procedure, and present status of First Elementary Dairy Courses.
3. Methods of conducting senior and graduate courses.
4. Departments represented in dairy instruction.
5. Determining the content of courses.
6. Factors determining the number of courses and students.
7. Instructional trends in instruction, equipment, and personnel.
8. Comments from institutions.

I2. Junior Colleges and Their Influence on Dairy Education. C. L. ROADHOUSE, Division of Dairy Industry, University of California.

During the past 20 years more than 500 junior colleges have been organized in 27 states of this country. The Office of Education of the United States Department of the Interior reports that junior colleges have found a place in American education for the purpose of teaching the traditional freshman and sophomore college courses.

During the past three years at the University of California more than 50 per cent of the students majoring in dairying have come from junior colleges and entered as junior students. The curriculum in junior college is not uniform and the students have not completed all lower division courses required for dairy students. This has interfered with students from junior colleges receiving the full Dairy Industry training during their junior and senior years.

Since few junior colleges offer an elementary course in dairying, upper division work in dairying cannot be taken at the Agricultural College until the second semester of the junior year. This usually interferes with the students enrolling in all the dairy courses offered. Experience has shown that students do not acquire the proper viewpoint of dairying when the dairy courses are crowded into four semesters.

Dairy students should be encouraged to spend at least six semesters in the college or university where their dairy training is secured. In some states junior college students are not permitted to transfer to the college or

university after the freshman year unless they have a high scholarship average.

If high school graduates cannot enter the agricultural college before the junior year, it will usually be necessary that they spend an extra semester or two at college in order to receive the same preparation and viewpoints of the students who enter as freshman.

13. Factors in the Retention of Knowledge. E. N. HANSEN, Dairy Husbandry Department, Iowa State College.

Much emphasis has been given to the acquisition of knowledge, but not very much to the conditions which make for its retention. The modern teacher is anxious to so prepare and give the subject matter that basic facts and principles will be retained by the student and be of use to him in his future work.

There are quite varied opinions among educators as to some of the conditions which affect permanent retention of knowledge. Most of them are agreed, however, that there are three factors of primary importance, namely:

    1. Interest in the subject.
    2. Understanding of the subject.
    3. Subsequent use of it in our thinking or work.

Experiments have been conducted to attempt to learn the importance of these and other factors. In an experiment by the Vocational Education Department at the Iowa State College, final examination questions in courses in Animal Husbandry, Farm Crops, Soils and Physics were given 50 students that had taken the courses two or more years before. Each person taking the examination was not only asked to answer the questions, but also to evaluate each of them on the following points: Interest, Understanding, and Use, as considered by him at the time that he took the course.

It was very evident, from this study, that facts such as dates, yields, names of persons or animals extinct or of minor importance are not retained by the average person. These types of questions also received the lowest rating as to the three points—Interest, Understanding and Use. In the case of many students, a general idea of such type of questions should be sufficient. Exceptions are the cases of students specializing in a certain field of work.

In the study of the four courses, the students retention grades and the actual grades that they had obtained when they took the courses, were compared. They were as follows, on a basis of 100:

	Course 1	Course 2	Course 3	Course 4
Retention Grades	35.0	73.9	71.6	49.57
College Grades	87.3	88.0	89.1	84.7

The scores on the three factors, Interest, Understanding and Use, were in the order of the retention grades, *i.e.*, lowest on Course 1 and highest on Course 2. Two of the ten questions in Course 1 were in regard to giving dates of certain events and three others were on identification of persons or things of minor importance. These five were largely memory questions and gave little chance of making strong connections or thought relationships during the course.

Some people have the ability to think or reason much more highly developed than others. One that has the ability to think can reason out a large number of questions asked, in the case of cause and effect questions. But in case of a strict memory question, nothing can be done if his memory has failed him.

A comparison of the retention grades and college grades shows that college grades may not measure what a person may be able to do with his information later, especially if based on memory questions.

Another experiment at the Iowa State College was in regard to Remembered and Forgotten Facts. Two hundred graduate students were asked to search through old notes or textbooks used in courses which had been taken by them at least two years previously and select six facts which they remembered clearly and six facts which they had completely forgotten. They then scored each of these facts in thirteen diffrent conditions or factors which were suspected by them of being important conditions in securing permanent retention.

The results showed that the three most important factors were: first, interest; second, subsequent use; and third, understanding. It is considered that the factor of associations is included in both subsequent use in thinking and in understanding. Visual impressions and illustrations were important factors.

The experiment brought out that the factors of emphasis by the teacher; learning by repetition; and the requirements by the teacher of attention and hard work are not important in securing retention. It is realized that these factors are important in the acquisition of knowledge but it appears that much of it is soon lost. The subject matter and methods of presentation should be given thorough consideration by the instructor.

14. Rapid Calculation of Rations by Means of a Pony. P. T. Dix Arnold, Florida Agricultural Experiment Station.

An accurate and rapid method of calculating rations for dairy cows is included as a part of laboratory exercises in the course, "Milk Production," offered in the curriculum of the University of Florida College of Agriculture. A pony sheet is made up by each student in laboratory on heavy ruled paper. Headings used are as follows:

Heart girth and estimated body weight.

Maintenance requirements, by 50-pound classes.

Nutrients required per pound of milk, interpolated by tenths of a per cent in butterfat test.

The reverse side of the pony sheet is arranged to carry the amounts of nutrients provided by each roughage, or concentrate mixture used locally. Each of these is calculated according to the pounds ordinarily used for cows with a commercial level of production, and "Rule of Thumb" feeding practises.

The pony is used as follows:

1. Estimate the live weight of a cow by measuring her heart girth.

2. From the pony sheet, obtain the maintenance requirements to the nearest 50-pound class.

3. Calculate production requirements from daily milk yield, and the appropriate fat percentage column on the pony.

4. The sum of "2" and "3" amounts to the total nutrients required.

5. Estimate the amount of roughage that will be fed, according to "Rule of Thumb." Substract the nutrients provided by these, from the total requirement.

6. The remaining nutrients required, not provided by the roughages, can be seen by a glance at the pony, to be provided by an appropriate number of pounds of the concentrate mixture to be used.

This method is not original with the author, but may be a help to students who later become cow testers, Smith-Hughes teachers, County Agents, or feed salesmen. When advising an inquirer, a quickly-calculated ration commands respect, whereas a delay of 5 to 10 minutes used in the old style long-hand calculation may lose the confidence of the inquirer.

15. College Creameries. THOS. B. HARRISON AND C. E. WYLIE, University of Tennessee.

Instruction in Dairy Manufacturing in Land Grant Colleges is carried on in almost all States. In order to make a study of this work, a questionnaire was sent to all of these colleges, and questionnaires were returned from 47 States. This material has been assembled and tabulated under the following general headings:

1. Colleges having creameries and the amount of various products handled.

2. The method of disposing of these products.

3. Purchases of raw materials including sources other than university herds.

4. The number, qualifications, and rates of pay of employees.

5. Various methods of financing and handling of creamery funds.

6. Services rendered to the State through creamery operations in addition to instructional work.

16. A Course in Milk and Public Health. H. O. HENDERSON, West Virginia University.

Need of Course. In the past, our milk inspectors have been recruited from men who have had no previous experience with milk. Some of these had taken courses in Sanitary Engineering, and were using the milk inspecting job as a stepping stone to something better, while many others were appointed because of political or other reasons. They were not interested in being dairy inspectors permanently nor were they capable of so being. The dairymen objected to many of these men because of this lack of interest and knowledge. Many of them were simply machines and could not make any decisions as they were not acquainted with the composition, food value, or fermentations of milk, nor the methods of producing clean milk. There is little wonder that many of the dairymen became antagonistic to the sanitation program. To train men for such jobs, and to give milk inspection the place that it should have, was the primary reason for the organization of the course in Milk and Public Health.

While the training of milk inspectors was the primary object, nevertheless it has proven very popular as an elective course to those students who wish to know something about milk but are not interested in going into a specialized dairy course. It is popular also with the dairy students—both those that are in the production field and those in the manufacturing field.

Content of the Course. The course is given for either 2 or 3 credits depending upon whether the student wishes to take the laboratory or not. The laboratory is strongly recommended for all those that wish to go into the inspection field as they go along closely with the lectures and supplement them very satisfactorily.

The course starts off with a study of milk, its compositions, properties and food value, so that the student will know the importance of milk. The contamination of milk with bacteria, and under certain conditions with disease producing organisms is discussed. This is followed with the methods used to safeguard the milk and to protect the public health. This leads into the discussion of milk ordinances and the duties of milk inspectors, and how one should review the whole matter of milk inspection so that one can have an impartial view of the entire problem.

Result of the Course. While this course has been given for only a few years, the results have been very gratifying. The State Department of Health is now looking to our department for their milk inspectors. Within the last two years, they have taken five district supervisors, and numerous county and city inspectors from those who have taken this course. The dairymen are also much better satisfied and are going along with the sanitation program better than before. Closer cooperation is being had with the extension service and the entire milk inspection movement has been put on a higher plane.

I7. The Desirability of an Advanced Course in Dairy Industry as a Requirement for Agricultural Students. KENNETH M. RENNER, Texas Technological College.

A number of reasons will be advanced for the desirability of requiring an advanced dairy industry course for agricultural students.

Certain trends in the occupations of agricultural college graduates make it highly desirable that they have more knowledge of the dairy industry than is made possible by the usual required, "Elements of Dairying Course."

An increasing number of agricultural college graduates are entering the field of vocational agricultural teaching, county agent work, or other branches of the business where they are placed in an advisory capacity to farmers. Statistics show that approximately one-fourth of the total agricultural income is derived from the sale of milk and its products. This indicates that more farmers are becoming interested in the dairy industry.

A brief discussion of such a course, which has been required at the Texas Technological College for the past five years, will be presented.

I8. Extramural Courses in Dairy Husbandry. H. A. RUEHE, University of Illinois.

The author discusses over twenty-five years of experience in adult education in dairy manufactures. He points out the change from the trade school type of short course which stressed the "how to do" instruction to the conference type of "why we do"; and the later development of the night school type of extra mural course.

The author reports upon the success of an extra mural course given in Chicago this past year with fifty-eight enrolled. The course carried 3 hours of University credit and was open to three classes of students:

1. Those able to meet the regular University entrance requirements.

2. Unclassified students, not able to meet University entrance requirements but who were over 18 years of age and experienced in dairy work.

3. Visitors who paid visitor's fee but who did not receive credit for the course.

The author also points out the demand for advanced extra mural courses in dairy manufactures and instruction of graduate calibre.

I9. Undergraduate Dairy Seminar. A. A. BORLAND, The Pennsylvania State College.

Objects of Course:

1. To teach the student how to educate himself by gathering and assembling all the available information on a given subject.

2. To give a general review of the dairy field of knowledge.

3. To give the student practice in the use of the library.

4. To afford the student practice in public speaking by the oral presentation of a given subject.

5. To teach the student to think for himself through discussion and debate in class.

Plan:

The first meeting is occupied with an explanation of the objects and plan of the course with an explanation of how to find material in the library on a given subject; how to assemble that material properly when found; what an abstract should contain; and what information a reference should give. Sample outlines, including proper arrangement of bibliography are distributed, also a list of subjects selected from recent investigational work of the agricultural experiment stations or commercial organizations. From this list first, second, and third choice may be made of subject to be presented in class by the student at a later date. The subjects are changed from year to year so as to have all topics timely and of real interest.

The subjects chosen are then given consideration by the instructor and one is assigned to each student so that no two have the same topic. A definite schedule is then arranged by the instructor assigning date when student is to submit outline and bibliography to instructor, date when complete write-up is due, and date when subject is to be presented in class.

The first four or five meetings of the class are devoted to a review of the experimental work in dairying at the institution in which the student is enrolled. The assigned subjects are then presented in the remaining periods throughout the semester. Sometimes prominent authorities on particular dairy subjects are also secured for addresses before the class.

In presenting the subject, the student is expected to speak orally for a period of 15 minutes. He may use illustrative material, charts, or tabular material on the blackboard, but must not read his paper. The date when the student is to hand in his outline and bibliography, including a starred reference for study by the whole class, is two weeks in advance of the date of his presentation in class. This material is mimeographed and a copy given each member of the class. The members are then expected to look up the starred reference, so that they will have some general knowledge of the subject when it is presented in class.

The first 10 minutes of the class period are used for a quiz on the present or preceding subject, the next 15–20 minutes by the speaker, and the last 15–20 minutes are devoted to general class discussion of the subject.

The complete write-up of the subject turned in by the student at the meeting prior to presentation in class is also mimeographed and copies distributed at the close of the class period in which the speaker presents the subject. Each student is expected to read over this article and be prepared for a 10 minute quiz on it at the following class period.

By this method each student has an outline, a bibliography, and a complete write-up, not only of his own subject, but also that of every other

member of the class. He thus gets a general review of the up-to-date information in various phases of dairying; he acquires the habit of "self-education" by amassing and assembling in logical order the information available on a particular subject; he receives practice in the use of the library, practice in public speaking, and practice in extemporaneous discussions.

I10. Practical Dairy Industry Experience and the Scholastic Record. E. F. Goss, Iowa State College.

An analysis of the practical plant experience and complete scholarship records to the spring quarter of 1937 of 239 undergraduate students majoring in dairy industry at Iowa State College during the 1936-37 academic year is presented. These men were enrolled in the following four year curricula, Dairy Industry, Dairy Industry and Chemistry, and Dairy Industry and Economics, and in the Two Year Curriculum for Creamery Operators.

Of the 239 students in all six classes 129 individuals or 53.9 per cent had obtained practical dairy experience before enrolling at Iowa State College. Of the students in the 4 year curricula 89 or 52.9 per cent had such experience prior to college entrance while among the two year students those with previous experience totaled 40 and comprised 56.3 per cent of the two classes. The average period of dairy experience prior to college entrance for the entrance group was 22.4 months and for the latter group 26.

An item of interest is the fact that in 61 instances or 25.5 per cent the fathers were or recently had been active in the industry at the time the student enrolled in the college course or in other words these men were second generation dairymen.

Vacation dairy plant experience is considered to be a distinct asset to the student and such experience had been obtained by 95.5 per cent of the senior classes and 100 per cent of the second year creamery operator students.

The scholastic average in all work taken expressed in terms of quality point average up to and including the winter quarter 1937, was 2.21 for those with experience compared with 1.94 for those without practical experience. For the dairy work alone the average for the two groups was 2.41 and 2.14 respectively.

I11. The Placement of Dairy Graduates. M. MORTENSEN, Iowa State College.

Training the Students for Specific Positions. Before a teacher is justified in recommending a graduate for a position he should know that the graduate has had the proper training and is in possession of other qualifications necessary for becoming successful in the particular field in which he seeks employment.

There are, generally speaking, three fields of work for which the college dairy departments prepare their students, namely, research, teaching, and commercial work. The men trained for research and teaching should have a good background in chemistry, bacteriology, physics, and mathematics. They should be willing and interested in taking advanced work leading to the degree, Ph.D. Men trained for the commercial field should be well grounded in economics and have a fair knowledge of chemistry, bacteriology, and mathematics. An additional year of graduate work would be desirable.

Contacting the Prospective Employer. The teacher or the senior counselor should become sufficiently well acquainted with the individual student to determine within a fair degree of accuracy the field for which the particular student is best qualified even to the extent of deciding about specific work within a certain field. There is within the commercial field demand for men of quite varied qualifications, such as sales work, field work, manufacturing, accounting, and for men who have ability to work into executive positions. The teacher should contact such organizations as may possibly be interested in employing men of qualifications as presented.

The teacher should not assume all the responsibility. It is preferable to have the student do the corresponding and have the teacher act as advisor. The successful student must know how to write a business letter, otherwise his application is unlikely to meet with favor. Dairy Industry students should all be required to take a course in business correspondence.

Certain graduates are more or less of the prospector type; they decide on some certain state or location in which they desire to locate and they appear in person applying for a position. A young man of a good personality will have many advantages in applying in person.

Assistance from the Alumni. The alumni are loyal to their Alma Mater. They never forget what the college did for them and they are happy to have a part in placing later graduates. A department keeping in close touch with its alumni will be assisted to an appreciable extent in placing graduates.

The Personnel Department. Most schools maintain a personnel department and the placing of graduates is frequently handled by that department. Since the dairy teachers are generally in close contact with the industry they represent, the placement of graduates can best be handled by the teachers of the dairy department if they all cooperate toward that end.

JOURNAL OF DAIRY SCIENCE

A NATIONAL SURVEY OF METHODS FOR THE DETERMINATION OF SEDIMENT IN BUTTER AND CREAM

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The Research Committee of the American Association of Creamery Butter Manufacturers undertook a cooperative study of sediment testing methods for churning cream and butter some time ago. A progress report on this study was submitted to the Dairy Science Association at its annual meeting (June, 1936). Since that time the study has been completed for an entire year, and the results presented here will, therefore, cover the survey in its entirety.

Since the advent of sediment testing on a large scale in connection with the National Cream Quality Program, many tests for sediment on cream and butter have been suggested and tried. In an effort to simplify and coordinate these efforts, this study was instigated to see whether or not a test using testers, pads, and standards similar to those used for milk might be satisfactory.

Accordingly the Research Committee of the Association organized a series of studies on a nationwide scale to help toward a solution of the problem. Further, this program was discussed and met with the approval of the Associate Referee on Butter of the American Public Health Association.

The following groups of states were represented by colleges and/or commercial laboratories:

1. East—comprising New York (Buffalo and Ithaca) and Ohio (Columbus and Cincinnati).

2. Central—comprising Indiana (Frankfort and Lafayette), Illinois (Chicago, Champlain, Peoria and Danville), Iowa (Des Moines, Sioux City and Ames).

3. West-Central—including Nebraska (Omaha), Missouri (Kansas City), and Kansas (Kansas City, Topeka and Manhattan).

4. North-Central—including Michigan (Bay City), Minnesota (Duluth), and North Dakota (Fargo).

5. South—comprising Kentucky (Louisville) and Tennessee (Nashville).

6. Southwest—Texas (Fort Worth).

7. West—including Oregon (Portland and Corvallis) and California (Davis).

<div align="center">PROCEDURE</div>

Originally each laboratory was asked to report on three cream and two butter samples each week. A number of the collaborators gave us complete data for the entire year. However, the number of reports for the last part of our study was not as high as we had hoped for. No doubt this was due to the fact that spring and summer is the peak season for a creamery. Notwithstanding we are pleased to submit the results on 784 cream tests (three grades of cream used in each test) and 2261 butter sediment tests.

The determination of sediment in cream on each sample was made using the following methods: (1) Soda, (2) Lye, (3) Ammonia, and (4) Acid. The details were as follows:

Cream. A sample of cream was taken from a can of patron's cream only after it had been thoroughly stirred or mixed, using a hand agitator. After the cream had been' thoroughly stirred or mixed in the patron's can, at least one quart of the cream was placed in a suitable container. The quart sample of cream was then warmed to approximately 85°–90° F. This warmed cream sample was stirred thoroughly until it poured readily, at which time two ounce portions were secured for the different testing methods. Once each week, cream samples as described above were prepared from the cream cans of three patrons. Where possible, cream of varying acidities and varying degrees of sediment were selected.

Butter. A sample of butter was taken from the product representative of a commercial churning. One pound of butter was used for this purpose, care being taken to obtain the same from various parts of the churn, so as to be representative. The butter samples were collected in a suitable container. . The one pound sample of butter was warmed to approximately 85°–90° F., care being taken to stir the same constantly during the warming period. The warmed butter sample which had been stirred thoroughly during the warming period was divided into 100 gram portions for treatment by the different testing methods. Once every week, butter samples as described above were prepared from three different commercial churnings representing, as nearly as possible, the different grades of butter being churned.

<div align="center">TESTING METHODS TO BE APPLIED TO CREAM SAMPLES</div>

The acidity of the cream sample was determined using a nine gram sample in the titration against N/10 sodium hydroxide to the phenolphthalein endpoint. The fat content of the sample was determined by the Babcock, method.

Soda Method. A two ounce sample of cream was placed in a granite-ware container or glass beaker. Eight ounces of two per cent bicarbonate of soda solution which had been previously heated to 180° F. were then added; it was then stirred thoroughly and run through the sediment tester. The sediment tester was rinsed out with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts and classified, and sealed with a metal clasp or staple in a cellophane envelope.

Lye Method. A two ounce sample of cream was placed in a granite-ware container or glass beaker. Nine cc. acid dipper amount of one per cent lye (sodium hydroxide) solution was added; it was stirred thoroughly and allowed to stand two minutes in the cold, then four ounces hot water (185° F.) was added mixing thoroughly and run through sediment tester. Sediment tester was rinsed with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts, classified, and sealed with a metal clasp or staple in a cellophane envelope.

Ammonia Method. A two ounce sample of cream was placed in an enamel or graniteware container or glass beaker. Eight ounces of ammonia solution (6 cc. NH$_4$OH—specific gravity 0.90 per 1000 cc. water) were added, which had previously been heated to 180° F.; it was stirred thoroughly and run through the sediment tester. The sediment tester. was rinsed with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts, classified and sealed with metal clasp or staple in a cellophane envelope.

Acid Method. A two ounce sample of cream was placed in a graniteware container or glass beaker; 200 cc. of N/20 HCl (4.5 cc. conc. HCl in 1000 cc. water) were added. The mixture was heated over a water bath to 165° F., stirring thoroughly to insure complete mixing, and run through the sediment tester. The sediment tester was rinsed with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts, classified and sealed with a metal clasp or staple in a cellophane envelope.

TESTING METHODS TO BE APPLIED TO BUTTER SAMPLES

Hot Water Method. A 100 gram sample of butter was placed in an enamel or graniteware container or glass beaker. Eight ounces of hot filtered water (185° F.) were then added. Then the mixture was heated on the water bath to a temperature of 165° F., stirring thoroughly to insure complete melting and mixing of the butter, and run through the sediment tester. The sediment tester was then rinsed with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts, classified and sealed with a metal clasp or staple in a cellophane envelope.

Soda Method. A 100 gram sample of butter was put in a graniteware

container or glass beaker and eight ounces of two per cent bicarbonate of soda solution which had been previously heated to 180° F. were added. The mixture was heated on the water bath to a temperature of 165° F., stirring thoroughly to insure complete melting and mixing of the butter, and run through the sediment tester. The sediment tester was rinsed with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts, classified and sealed with a metal clasp or staple in a cellophane envelope.

Borax Method. A 100 gram sample of butter was placed in a graniteware container or glass beaker. Eight ounces of four per cent borax solution were added. The mixture was heated over a water bath to 165° F., stirring thoroughly to insure complete melting and mixing of the butter, and run through the sediment tester. The sediment tester was rinsed with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts, classified and sealed with a metal clasp or staple in a cellophane envelope.

Acid Method. A 100 gram sample of butter was placed in an enamel or graniteware or glass beaker container. Then 200 cc. of N/20 HCl (4.5 cc. conc. HCl in 1000 cc. water) were added to the mixture and heated over a water bath to 165° F., stirred thoroughly to insure complete mixing, and run through the sediment tester. The sediment tester was rinsed with at least four ounces of hot water (185° F.). The soiled lintine discs were mounted on cardboard inserts, classified and sealed with a metal clasp or staple in the cellophane envelope.

The sediment pads were compared with the Connecticut Official Milk Sediment Standards of 1931[*] to determine the relative amount of soiling. This was done both by the Association and cooperating laboratories (except for Fall 1935).

In most cases the results are shown for three grades of cream used in the particular area reporting. A division of the data on the butter samples was not possible.

<center>RESULTS</center>

Table I gives the average results in the age, acidity and fat content for all the cream samples. Almost without exception, the lower the grade of the cream, the older it was, the higher its acidity, and the lower the fat content. It was further noted that there was more variation between sections in respect to acidity of number one cream than there was among the acidities of the other three grades of cream from the same section. This is taken to mean that while acidity may be used to partially determine cream grade, it cannot be used to wholly classify it. The influence of season on acidity is clearly shown also.

[*] Connecticut State Department of Health, Hartford, Connecticut.

TABLE I

Age, acidity, and fat content in three grades of cream

DATE		NO. OF REPORTS	AGE			ACIDITY			FAT		
			Grade			Grade			Grade		
			1	2	3	1	2	3	1	2	3
			days	days	days	per cent	per cent	per cent	per cent	per cent	per cent
Plants											
Fall	1935	171	4	6	8	.40	.54	.60	34	32	30
Winter	1936	204	4	5	6	.39	.50	.61	33	33	32
Spring	1936	127	4	5	6	.47	.65	.75	35	33	32
Summer	1936	90	4	5	6	.68	.76	.94	35	34	33
Average		592	4	5	6	.46	.58	.68	33	33	32
Colleges											
Fall	1935	53	3	4	5	.29	.36	.41	33	32	29
Winter	1936	72	3	4	5	.24	.34	.45	35	32	33
Spring	1936	50	3	4	4	.27	.40	.51	37	34	31
Summer	1936	17	1	1	1	.14	.19	.29	33	32	34
Average		192	3	4	4	.25	.35	.44	34	32	31
Combined											
Fall	1935	224	4	5	6	.38	.49	.55	33	32	30
Winter	1936	276	4	4	5	.35	.45	.56	33	32	32
Spring	1936	177	4	5	5	.41	.58	.68	37	33	32
Summer	1936	107	4	4	5	.60	.67	.83	35	34	33
Average		784	4	5	6	.41	.52	.63	33	33	32

TABLE II

Filtration of cream samples using three methods, expressed as a percentage of distribution of the success secured on the different samples

DATE		NO. OF REPORTS	SODA									AMMONIA									ACID								
			First Grade			Second Grade			Third Grade			First Grade			Second Grade			Third Grade			First Grade			Second Grade			Third Grade		
			S	SL	F	S	SL	F	S	SL	F	S	SL	F	S	SL	F	S	SL	F	S	SL	F	S	SL	F	S	SL	F
Plants																													
Fall	1935	171	90	6	4	83	12	5	77	12	11	92	6	2	93	6	1	84	11	5	98	2	0	99	1	0	98	2	2
Winter	1936	204	93	4	3	89	5	6	80	11	9	96	2	2	92	7	1	85	12	3	97	2	1	96	3	1	96	3	1
Spring	1936	127	83	5	12	80	6	14	75	10	15	92	2	6	84	7	9	83	8	9	97	2	1	97	2	1	97	2	1
Summer	1936	90	81	10	9	74	14	12	74	13	13	95	4	1	92	6	2	87	8	5	100	0	0	98	1	1	98	1	1
Average		592	88	6	6	83	9	8	76	12	12	94	4	.2	91	6	3	85	10	5	98	1.5	.5	98	1.5	.5	97	2	1
Colleges																													
Fall	1935	53	90	8	2	92	8	0	81	15	4	89	9	2	77	19	4	77	17	6	96	4	0	98	2	0	92	8	0
Winter	1936	72	91	6	3	90	9	1	86	7	7	83	17	0	89	7	4	80	10	10	99	1	0	97	3	0	94	6	0
Spring	1936	50	80	18	2	84	6	10	78	12	10	86	10	4	82	16	2	62	26	12	98	2	0	100	0	0	98	0	2
Summer	1936	17	100	0	0	100	0	0	100	0	0	88	12	0	88	12	0	88	6	6	100	0	0	100	0	0	100	0	0
Average		192	89	9	2	90	7	3	84	10	6	86	12	2	84	13	3	76	15	9	98	1.5	.5	98	1.5	.5	95	4	1
Combined																													
Fall	1935	224	90	7	3	85	11	4	79	13	8	91	7	2	89	9	2	83	11	6	98	2	0	99	1	0	96	4	0
Winter	1936	276	92	5	3	89	6	5	81	11	8	93	6	1	91	7	2	84	11	5	98	1	1	96	3	1	95	4	1
Spring	1936	177	81	9	10	81	6	13	76	11	13	91	4	5	83	9	8	77	13	10	97	2	1	97	2	1	97	1	2
Summer	1936	107	85	8	7	78	12	10	73	13	14	93	6	1	91	7	2	87	8	5	100	0	0	98	1	1	97	2	1
Average		784	88	7	5	85	8	7	79	11	10	92	6	2	89	8	3	83	11	6	98	1.5	.5	98	1.5	.5	96	3	1

S—Satisfactory, SL—Slow, F—Failure.

In reporting results, the cooperating laboratories were asked to state whether or not filtration was (1) satisfactory, (2) slow, or (3) a failure. Table II shows the percentage of samples which fell into these three classes. As in the previous tables the data are separated by grade and season. Due to the poor showing of the lye method during the fall period, it was dropped from the study. The data were separated by section also, but there were no essential difference, and to conserve space, this comparison has been omitted from this paper. The table clearly shows the following order is taken by the different methods in respect to the percentage of successful filtrations.

    (1) Acid—grand average   98%

    (2) Ammonia—grand average   88%

    (3) Soda—grand average   84%

    (4) Lye—grand average   61% (fall only)

It is also very evident, that except for the acid method, the lower grades of cream filtered more poorly. The acid method was highly successful on all grades of cream, in all territories, and at all seasons.

Aside from the acid method the methods worked with different degrees of success in the different sections. For instance, the college group found the ammonia method less satisfactory than the soda method, whereas the opposite is true of the commercial laboratories. Aside from differences in the cream, no doubt, "getting used to the method" played an important part in making one or another of the methods more successful. In other words, the acid method was more foolproof than the ammonia or soda procedures.

Table III shows the average sediment scores for the cream samples separated as to grade, season, place of grading, and method of testing. As stated previously, the figures were obtained by comparing the sediment discs directly with the Connecticut Standards. Here again the lack of space, and due to the fact that there was little or no sectional influences, distribution of the data by sections has been eliminated.

The results show quite definitely that the lower the grade of cream, the higher the sediment score. The shift with grade does not, however, represent the difference between two discs on the Standard Chart. The acid method produced the cleaner pads while the soda and ammonia methods produced pads about equally clean. Careful observation on this point has revealed that this difference in degree of soiling was in all probability due to the presence or absence of undissolved curd or curd-solvent scum, rather than any real differences in the amount of dirt.

Another interesting point is to be derived from these data. The plant laboratories tended to score their sediment pads cleaner than did the Asso-

TABLE III
Average scores cream sediment pads using three methods

DATE	NO. OF REPORTS	SODA						AMMONIA						ACID					
		Association			**Plant**			**Association**			**Plant**			**Association**			**Plant**		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Plants																			
Fall 1935	171	28	37	43	—	—	—	29	39	51	—	—	—	25	32	41	—	—	—
Winter 1936	204	22	25	30	17	19	24	26	33	38	17	23	31	18	21	28	12	14	26
Spring 1936	127	36	37	33	31	34	35	38	41	42	35	36	36	23	29	33	27	29	33
Summer 1936	90	39	34	38	40	37	42	36	26	46	41	37	46	32	34	42	37	39	43
Average	592	29	34	37	25	27	32	31	35	43	27	30	35	23	28	35	21	24	29
Colleges																			
Fall 1935	53	21	21	26	—	—	—	15	22	25	—	—	—	10	16	13	—	—	—
Winter 1936	72	8	9	8	10	10	11	4	6	9	8	7	9	2	7	10	7	5	8
Spring 1936	50	11	12	13	17	17	18	17	16	15	18	21	19	10	11	13	14	20	16
Summer 1936	17	16	15	12	—	—	—	13	16	18	—	—	—	9	10	12	—	—	—
Average	192	13	13	15	13	13	14	11	14	16	12	13	13	7	11	12	10	11	11
Combined																			
Fall 1935	224	26	33	38	—	—	—	20	30	39	—	—	—	21	28	34	—	—	—
Winter 1936	276	18	21	25	14	16	21	19	25	29	14	16	22	14	18	23	11	12	16
Spring 1936	177	28	29	27	29	31	32	29	31	33	29	32	30	20	24	28	25	27	30
Summer 1936	107	35	31	37	—	—	—	32	30	41	—	—	—	28	29	36	—	—	—
Average	748	25	27	29	21	24	27	26	29	36	25	26	31	20	24	28	19	21	25

ciation laboratory. This was, no doubt, due to more strict observation of the pads by the latter.

TABLE IV

Filtration rate of butter samples using four methods, expressed as a percentage distribution of the success secured on the different samples

DATE		NO OF REPORTS	HOT WATER			SODA			BORAX			ACID		
			S	SL	F	S	SL	F	S	SL	F	S	SL	F
Plants														
Fall	1935	490	91	6	3	86	10	4	67	22	11	90	8	2
Winter	1936	576	94	5	1	93	5	2	82	13	5	94	5	1
Spring	1936	370	90	4	6	85	8	7	77	10	13	90	10	0
Summer	1936	276	86	4	10	81	9	10	57	25	18	90	5	5
Average		1712	91	5	4	87	8	5	69	18	13	92	6	2
Colleges														
Fall	1935	149	81	18	1	80	16	4	56	28	16	92	5	3
Winter	1936	215	87	12	1	91	9	0	76	17	7	98	1	1
Spring	1936	144	82	17	1	87	12	1	74	24	2	95	4	1
Summer	1936	41	90	5	5	68	27	5	39	22	39	100	0	0
Average		549	88	11	1	86	13	1	67	23	10	95	3	2
Combined														
Fall	1935	639	89	9	2	85	11	4	64	24	12	91	7	2
Winter	1936	791	92	7	1	92	6	2	80	14	6	95	4	1
Spring	1936	514	88	8	4	86	9	5	76	14	10	95	2	3
Summer	1936	317	87	4	9	79	11	10	55	25	20	91	5	4
Average		2261	90	6	4	87	9	4	70	18	12	93	5	2

S—Satisfactory, SL—Slow, F—Failure.

BUTTER SEDIMENT TESTS

The results of the sediment tests on butter are shown in Table IV Surprising though it may seem, the hot water method rated close to the acid method in the percentage of successful filtrations. The soda method also proved quite satisfactory most of the year. The borax method was least desirable from this point of view, being particularly poor in the summer and fall months of the year. The grand average percentage of successful filtrations were as follows:

(1) Acid 93%
(2) Hot Water 90%
(3) Soda 87%
(4) Borax 70%

SCORING BUTTER SEDIMENT PADS

Table V shows the scores for the butter sediment pads. Except for the fall period the pads were scored both in Chicago and at the plant or college laboratory.

TABLE V

Average scores on butter sediment pads

DATE	NO. OF REPORTS	HOT WATER		SODA		BORAX		ACID	
		Assn.	Plants	Assn.	Plants	Assn.	Plants	Assn.	Plant
Plants									
Fall 1935	490	34		40		49		36	
Winter 1936	576	27	14	32	17	39	20	27	16
Spring 1936	370	33	32	36	32	41·	34	32	38
Summer 1936	276	36	38	40	43	50	52	35	40
Average	1712	32	25	37	29	44	32	32	25
Colleges									
Fall 1935	149	27		33		39		26	
Winter 1936	215	16	14	20	12	18	16	17	13
Spring 1936	144	20	12	21	15	29	18	20	14
Summer 1936	41	24	27	25	30	31	33	26	28
Average	549	21	15	25	21	27	23	21	16
Combined									
Fall 1935	639	33		39		47		34	
Winter 1936	791	24	14	28	18	34	18	24	15
Spring 1936	514	29	26	32	28	38	28	28	25
Summer 1936	317	34	37	38	45	49	56	33	38
Average	2261	29	22	34	27	40	31	29	23

The degrees of soiling were very closely related to the ease of filtering; the borax filter pads had the highest scores. The hot water and acid methods provided the cleanest pads. Although the differences are not great they are, no doubt, significant. Naturally, the explanation follows the same line as that given for the cream sediment pads. Further work must be pursued in order to establish the point, however.

SUMMARY

The results of this investigation indicate that:

1. Cream and butter are most satisfactorily tested for sediment using the acid method. The lye method for cream and the borax method for butter proved to give a great number of unsatisfactory filtrations and were therefore impracticable for routine work.

2. The standard lintine discs and sediment testers used for milk were satisfactorily used in these tests.

3. The Connecticut Official Milk Sediment Standards, 1931, may be used for interpretation of results.

4. Indications were established showing that undissolved curd or curd-solvent scum caused pads to appear dirtier with certain curd solvents than with those which produced no such residue.

THE EFFECT OF BREED CHARACTERISTICS AND THE PLANE OF NUTRITION OF THE COW ON THE VITAMIN A POTENCY OF MILK*

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The natural pigmentation of milk produced by various breeds of dairy cattle under comparable conditions is known to vary with different breeds. The Guernsey and the Jersey breeds produce a more highly pigmented milk than do the cows of the Holstein, Ayrshire, and Brown Swiss breeds. This yellow color is restricted almost entirely to the milk fat and is due primarily to carotene. Since carotene is now recognized as a precursor of vitamin A, it would seem logical to postulate that butter made from Guernsey or Jersey milk should possess greater vitamin A potency than butter made from the milk of the Holstein, the Ayrshire, or the Brown Swiss breeds. Furthermore, Jersey and Guernsey milks, in addition to having a higher color value, also have a higher average fat content. In view of these facts, it would appear that there should be a difference in the vitamin A potency of these milks, especially if carotene alone is responsible for this biological activity. Milk fat, however, does not owe all of its vitamin A activity to carotene. Morton and Heilbron (1) have demonstrated by spectographic analysis that milk fat contains both carotene and vitamin A. Moore (2) has likewise demonstrated that milk fat contains both carotene and vitamin A and that cows convert carotene into vitamin A.

Davis and Hathaway (3) studied the vitamin A potency of milk from Holstein, Jersey, Ayrshire, and Guernsey cows, and concluded that there was no significant difference in the vitamin A content of these milks. Hathaway and Davis (4) reported that Holstein cream contained more vitamin A than Jersey cream. Wilbur, Hilton and Hauge (5) made a comparison of the vitamin A activity of butters from one group of Ayrshire and two groups of Guernsey cows fed under identical conditions. As the result of these studies they concluded that the vitamin A activity of the samples of butter were similar, regardless of the breed of cows or the color of butter. Sutton and Krauss (6) of the Ohio Station concluded that Hol-

stein milk fat had a greater vitamin A potency per unit weight than did Guernsey milk fat, in spite of the fact that the Guernsey milk fat was richer in carotene. Booth, Kon and Gillam (7) compared the vitamin A activity of Shorthorn and Guernsey butters produced from cows kept under comparable conditions of feeding and management. These butters were found to be identical in vitamin A activity. Baumann *et al.* (8) made a study of the influence of breed and diet of cows on carotene and vitamin A content of the butter produced. These investigators used spectroscopic methods for determining carotene and vitamin A, and reported definite breed differences when the cows received high and low carotene diets. However, when total biological activity of the several butters were calculated, they found this breed difference to be small.

It is clearly evident that the data presented in the foregoing literature are not in complete agreement with regard to several pertinent points. It is therefore obvious that additional information on a number of these points would be of material value.

The present investigation was undertaken in order to obtain further data concerning the effect of breed characteristics and the plane of nutrition of the cow on the vitamin A potency of milk.

EXPERIMENTAL PROCEDURE

The present investigation may be regarded as consisting of four distinct phases, viz.

I. The vitamin A potency of milks from cows representing breeds that normally produce highly pigmented and poorly pigmented milks when fed a good ration similar to those commonly employed in commercial feeding practice.

II. The vitamin A potency of milks from cows as in I, but fed a pigment poor ration.

III. The vitamin A potency of milks from cows as in II when large daily doses of commercial carotene were included in the ration.

IV. The vitamin A potency of milks produced by five standard dairy breeds under identical feeding conditions.

The cows selected for each phase of this study were true representatives of the respective breeds and the stages of lactation and gestation were as nearly identical as possible. The cows were milked the same number of times daily, were treated as nearly alike as possible and were maintained in individual stalls so constructed that access to food substances other than those intended for the particuar animals was not possible. Each animal received, daily, an accurately weighed quantity of ration in the form of a grain mixture and roughage. An aliquot portion of the milk produced at each of the three milkings during the twenty-four hour period was fed the same day to test rats, in the usual manner, in order to determine its vitamin

A potency. This procedure was followed in studying each phase, with minor modifications which will be mentioned later.

1. The vitamin A potency of milks from cows representing breeds that normally produce highly pigmented and poorly pigmented milks when fed a good ration similar to those commonly employed in commercial feeding practice

In the first phase of the investigation an attempt was made to determine the vitamin A content of milks from Guernsey and Holstein cows which were fed a good dairy ration that is commonly fed in commercial feeding practice. For this phase of the study two groups of cows (two Holstein and two Guernseys in each group) were selected from the experiment station herd as experimental subjects.

The four cows in Group 1 were placed on a diet composed of a good quality dehydrated clover hay and a grain mixture (300 parts corn and cob meal, 200 parts of oat feed, 250 parts barley feed, 50 parts distillers' grain, 125 parts cottonseed meal, and 50 parts gluten feed) which was the usual ration fed to the test cows in the station herd. The cows received this diet for one month previous to the test period. The purpose of this preliminary feeding period was to give the cows sufficient time to start producing milk uniform in vitamin A.

Although the rat data were fairly conclusive as to the vitamin A potency of the milk produced by the four cows, it was deemed advisable to repeat the experiment in order to have more conclusive data. For this purpose other Holsteins and Guernseys were used. These cows received the same basal diet and roughage and were handled in the same manner as the cows in the previous experiment.

Tables 1 and II present the vitamin A potencies of milks produced by representative Guernsey and Holstein cows while receiving a normal dairy ration.

Table II shows the average vitamin A potencies of milks produced by a second series of Guernsey and Holstein cows receiving a normal dairy ration.

From the data presented in Tables I and II, it is quite evident that equal volumes of milk from cows of different breeds receiving a normal dairy ration are not equally potent in vitamin A as reported by Davis and Hathaway (3). There appears also to be a wide difference in the vitamin A potency of milks produced by different cows of the same breed. The milks from Holstein cows Nos. 1709 and 1711 were very low in vitamin A as compared with the milk from Guernsey cow No. 1673 and Holstein cow No. 1489. The rats receiving 0.6 cc. of milk from cows Nos. 1709 and 1711 were unable to maintain their body weights, while the rats receiving a like amount of milks from cows Nos. 1673 and 1489 made an average gain of 31 and 34

TABLE I

The vitamin A potencies of milks produced by representative Guernsey and Holstein cows receiving a normal dairy ration

COW NO	BREED	NUMBER OF RATS	AMOUNT MILK FED CC	AVERAGE WEIGHT OF RATS AT END OF DEPLETION PERIOD GMS	AVERAGE WEIGHT OF RATS AT END OF EXPERIMENT GMS	AVERAGE GAIN IN WEIGHT GMS	AVERAGE DAILY GAIN PER GRAM MILK FED	APPROXIMATE VITAMIN A UNITS PER QUART (SHERMAN)
1453	Holstein	2	0.4	69	66	-3		
1453	Holstein	4	0.6	83	97	14	0.617	1447
1453	Holstein	5	0.8	79	107	28		
1489	Holstein	3	0.4	84	84	0		
1489	Holstein	3	0.6	85	119	34	1.07	3511
1489	Holstein	5	0.8	72	106	34		
1571	Guernsey	2	0.4	78	77	-1		
1571	Guernsey	5	0.6	74	100	26	0.902	2620
1571	Guernsey	5	0.8	79	104	25		
1673	Guernsey	1	0.4	78	88	10		
1673	Guernsey	4	0.6	77	108	31	1.24	3203
1673	Guernsey	5	0.8	78	123	45		

TABLE II

The average vitamin A potencies of milks produced by a second group of Guernsey and Holstein cows receiving a normal dairy ration

COW NO.	BREED	NUMBER OF RATS	AMOUNT MILK FED CC.	AVERAGE WEIGHT OF RATS AT END OF DEPLETION PERIOD GMS.	AVERAGE WEIGHT OF RATS AT END OF EXPERIMENT GMS.	AVERAGE GAIN IN WEIGHT GMS.	AVERAGE DAILY GAIN PER GRAM MILK FED	APPROXIMATE VITAMIN A UNITS PER QUART (SHERMAN)
1709	Holstein	6	0.5	127	124	– 3		
1709	Holstein	2	0.6	141	130	–11		
1711	Holstein	4	0.5	121	105	–16		
1711	Holstein	5	0.6	95	90	– 5		
1546	Guernsey	5	0.5	128	150	22	1.22	1868
1546	Guernsey	4	0.6	120	145	25		
1548	Guernsey	6	0.5	128	128	0	0.50	1550
1548	Guernsey	4	0.6	115	134	19		

grams respectively during the experimental period. Holstein cow No. 1453 and Guernsey cows Nos. 1546 and 1548 produced milks containing about the same amounts of vitamin A. The vitamin A potency per unit volume of these milks was midway between the two extremes mentioned above. Wilber, Hilton and Hauge (5) stated that under similar feeding conditions the higher the percentage of fat in the milk, the greater was its vitamin A potency. The data presented herein are not in complete agreement with the above findings, as some cows produced milk of the same fat content and were found to differ considerably in vitamin A potency. In our study the vitamin A potency of the milk of individual cows was determined, whereas the vitamin A potency of the pooled milk from groups of cows was determined by the above mentioned investigators. If, however, the average vitamin A potency of the milk of the four cows from each breed is considered, the results are in close agreement with those of Wilbur and associates.

II. *The vitamin A potency of milks from cows representing breeds that normally produce pigment rich and pigment poor milks, the ration fed to all cows being of pigment poor quality*

The cows used in the latter part of the former experiment were also used for this phase of this investigation. After receiving a normal dairy ration for two months, these cows were fed a pigment poor ration. This ration consisted of a grain mixture, timothy hay of very poor quality and dried beet pulp. The grain mixture (300 parts bran, 200 parts oats, 200 parts barley, 100 parts linseed meal, 100 parts cottonseed meal, and 9 parts salt) was fed in amounts proportionate to the milk production. Twelve pounds of timothy hay of poor grade were fed to each cow daily. The Holstein cows received eight pounds of dry beet pulp daily, while the Guernseys received but six pounds daily. The cows received this diet from November, 1933, until June, 1934. After seven months, the cows were in poor physical condition, had lost weight, had declined in milk production, and had manifested marked symptoms of diarrhea. Five attempts were made during this seven-month period to determine the vitamin A potency of the milks from each of the four cows. The estimated amount of milk necessary to induce unit gain in weight was calculated at the beginning of each succeeding determination with the aid of the data previously established. These estimations were difficult to make, for at the time the experiment was being carried out no data were available to indicate the rapidity of depletion or the amount of time required to deplete the cows of their body stores of vitamin A. As a result, a number of these estimations proved to be low, and the rats receiving such quantities of milk were unable to maintain their body weights. In the last weeks of the experiment sufficient data had been collected, however, to make it possible to estimate more accurately the volume of milk necessary to induce unit gain. Table III presents a summary of the biological data

obtained while testing the milk from these cows which received a pigment-poor ration. During this phase of the work, many of the levels chosen proved to be too low, with the result that many of the rats on such levels died before the end of the curative period. The data from those rats which made significant responses are included in this table. The table contains a summary of the growth responses of only 130 rats, although 250 rats were used in this phase of the study.

The data in Table III show that Guernsey cow No. 1546 produced milk containing the highest vitamin A potency per unit volume. Holstein cow No. 1711, on the other hand, produced milk with the lowest vitamin A potency. It is also evident that the milk from the two Guernsey cows was richer in vitamin A than the milk of the two Holstein cows. The milk from Guernsey cow No. 1546 contained approximately 1550 units per quart at the beginning of the depletion period and 513 units at the end of the depletion period. This reduction in vitamin A represents approximately 66 per cent of the total. Likewise, milk from Guernsey cow No. 1548 contained 1550 units of vitamin A at the beginning of the depletion period and less than 405 units at the end of the seven months' period. This represents a decrease of approximately 73 per cent of the total vitamin A potency.

It is impossible from the data obtained to calculate the vitamin A potency of the milks from Holstein cows Nos. 1709 and 1711 at the beginning of the depletion period. However, it may be assumed that it contained approximately 900 units per quart in the beginning. The data obtained show that they contained an average of 255 units per quart at the end of the depletion period. If the above assumption is correct, the milks from the two Holstein cows lost 70 per cent of their original vitamin A potency during the seven months' period on a pigment-poor diet. This reduction in vitamin A potency is approximately the same as that found with the Guernsey milks. The data indicate that the rate of decrease in total vitamin A potency of milks produced under these adverse feeding conditions was about the same for the two breeds studied.

The foregoing results agree with those reported by Fraps, Copeland and Treichler (10). These investigators reported that the milks which they tested contained from 33 to 38 Sherman units of vitamin A per gram of fat in the beginning and from 5 to 12 units after the cows had been on a pigment-poor diet for five months. Gillam and coworkers (9) in England found that in the case of cows receiving a normal winter ration of hay and concentrates, the vitamin A potency of butter fell from approximately 16 International units of vitamin A per gram in the beginning to approximately 5 units at the end of six months. This represents a reduction of approximately 68 per cent, a result which compares favorably with that obtained in these studies.

These results are in agreement with those reported in Tables I and II

TABLE III

Results obtained in a progressive series of vitamin A assays made on milks produced by representative Guernsey and Holstein cows receiving a pigment poor ration

PERIOD	BREED	COW NO.	NUMBER OF RATS	DOSE CC.	AVERAGE WEIGHT OF RATS AT END OF DEPLETION PERIOD GMS.	AVERAGE WEIGHT OF RATS AT END OF EXPERIMENT GMS.	AVERAGE GAIN IN WEIGHT GMS.	AVERAGE DAILY GAIN PER GRAM MILK FED	APPROXIMATE VITAMIN A UNITS PER QUART (SHERMAN)
11/25 to 12/30	Guernsey	1546	5	0.6	115.2	122.8	7.6	.36	Less than 1550
12/19 to 1/23	Guernsey	1546	4	0.6	150.5	150.5	0.0		
12/19 to 1/23	Guernsey	1546	3	0.8	114.0	131.3	17.3	.62	1167
3/25 to 4/29	Guernsey	1546	3	1.0	118.3	138.0	19.7	.56	934
3/25 to 4/29	Guernsey	1546	3	1.3	104.0	132.6	28.6	.62	710
3/25 to 4/29	Guernsey	1546	4	1.6	117.8	138.7	21.0	.37	551
4/15 to 5/29	Guernsey	1546	5	1.6	67.2	80.0	12.8		
6/ 9 to 6/13	Guernsey	1546	7	1.8	104.4	125.0	20.6	.32	513
11/25 to 12/30	Guernsey	1548	5	0.6	114.6	104.8	9.8		
12/19 to 1/23	Guernsey	1548	4	0.6	108.0	118.5	10.5	.49	1550
3/25 to 4/29	Guernsey	1548	4	1.0	115.7	109.0	- 6.7		
3/25 to 4/29	Guernsey	1548	4	1.3	117.7	121.5	3.7		
3/25 to 4/29	Guernsey	1548	4	1.6	113.2	122.5	9.2		
4/12 to 5/29	Guernsey	1548	5	2.0	73.0	85.4	12.4	.17	467
6/ 9 to 6/13	Guernsey	1548	9	2.3	102.6	108.7	6.1	.08	Less than 405

TABLE III—(Continued)

PERIOD	BREED	COW NO.	NUMBER OF RATS	DOSE CC.	AVERAGE WEIGHT OF RATS AT END OF DEPLETION PERIOD GMS.	AVERAGE WEIGHT OF RATS AT END OF EXPERIMENT GMS.	AVERAGE GAIN IN WEIGHT GMS.	AVERAGE DAILY GAIN PER GRAM MILK FED	APPROXIMATE VITAMIN A UNITS PER QUART (SHERMAN)
11/25 to 12/30	Holstein	1709	4	0.8	111.2	111.0	-0.2		900
12/19 to 1/23	Holstein	1709	4	0.8	111.5	100.2	-11.3		
3/25 to 4/29	Holstein	1709	2	1.0	110.0	95.5	-14.5		
3/25 to 4/29	Holstein	1709	4	1.3	122.2	124.5	2.3		
3/25 to 4/29	Holstein	1709	4	1.6	112.5	115.7	3.2		
4/15 to 5/29	Holstein	1709	4	2.0	73.5	75.7	2.2		
6/ 9 to 6/13	Holstein	1709	9	3.5	107.6	124.3	16.7	.13	266
11/25 to 12/30	Holstein	1711	4	0.8	101.7	91.2	-10.5		900
12/19 to 1/23	Holstein	1711	3	0.8	127.6	113.6	-14.0		
12/19 to 1/23	Holstein	1711	3	1.0	100.6	87.3	-13.3		
3/25 to 4/29	Holstein	1711	4	1.0	102.5	81.0	-21.3		
3/25 to 4/29	Holstein	1711	4	1.3	107.7	110.5	2.8		
3/25 to 4/29	Holstein	1711	4	1.6	106.5	106.3	-0.2		
4/15 to 5/29	Holstein	1711	2	2.0	67.0	71.0	4.0		
6/ 9 to 6/13	Holstein	1711	6	3.8	109.0	124.6	15.6	.12	245

of the present study, namely, that Guernsey milk contains more vitamin A per unit volume than Holstein milk.

III. The vitamin A potency of milks from cows representing breeds that normally produce pigment-rich and pigment-poor milks, the ration fed to all cows being pigment-poor but highly fortified with a commercial carotene preparation

The cows used in the previous experiment that had been depleted of their body stores of vitamin A were also used for this study. It was planned to feed daily 150,000 A.D.M.A. units of vitamin A in the form of carotene to each of the depleted cows for a period of twelve days. A twelve-day feeding period was subdivided into three equal periods and a biological study for increased vitamin A potency was made on aliquot portions of the milk produced during each of these periods. All the milk from each of the four cows was collected and kept in ice water for four days, after which it was pooled. Approximately 80 cc. portions of the composited milks were placed in individual cardboard containers and these in turn were placed in a cold room at −15° F. where they were frozen and stored until used. The milks from the last four days of the depletion period were also collected and stored in the same manner. As the milks were needed for the biological assays they were removed from cold storage and allowed to thaw at room temperature, previous to feeding.

The four depleted cows were fed daily carotene equivalent to 150,000 units of vitamin A for a twelve-day period. This carotene was supplied to each animal by feeding 51 cc. of a commercial carotene preparation which contained 3,000 A.D.M.A. units of vitamin A per gram.* This amount of carotene was considered sufficient to cause the cows to regain their body stores of carotene and to secrete milk of at least normal vitamin A potency by the end of the twelve-day period. The twelve days were divided into three periods to study (by the biological response method) any increase in vitamin A potency of the pooled milks during these successive collection periods. The method of sampling and preserving of the milks is described above. Since it was necessary to know the vitamin A potency of the milks before the carotene feeding began, the milk from the last four days of the depletion period was collected and pooled.

Table IV presents a summary of the biological assay data collected. It is evident from these data that 150,000 A.D.M.A. units of vitamin A in the form of carotene per cow per day for a twelve-day period did not bring about the expected increase in vitamin A potency. It is probable that a twelve-day period is insufficient time for the cows to secrete milk of normal vitamin A potency under such feeding conditions. Three of the four cows used in this study seemed to give the same response to intensive carotene

* The commercial carotene was supplied gratis by the S.M.A. Corporation, Cleveland, Ohio.

TABLE IV

Summarizing the results of a progressive series of vitamin A assays made on milks produced by representative Guernsey and Holstein cows after being changed from a pigment poor ration to a pigment rich ration

CAROTENE FEEDING PERIOD	COW NO.	NUMBER OF RATS	DOSE CC.	AVERAGE WEIGHT OF RATS AT END OF DEPLETION PERIOD GMS.	AVERAGE WEIGHT OF RATS AT END OF EXPERIMENT GMS.	GAIN IN WEIGHT GMS.	APPROXIMATE VITAMIN A UNITS PER QUART (SHERMAN)
Last 4 days of depletion period	1546	7	1.8	104.4	125.0	20.6	
First 4 days carotene feeding	1546	9	1.8	81.3	101.2	19.9	
Second 4 days carotene feeding	1546	7	1.8	82.0	107.2	25.2	450
Third 4 days carotene feeding	1546	6	1.8	98.6	127.5	28.9	
Last 4 days of depletion period	1548	9	2.3	102.6	108.7	6.1	
First 4 days carotene feeding	1548	10	2.3	78.1	97.3	19.1	
Second 4 days carotene feeding	1548	7	2.3	90.6	109 7	18.8	400
Third 4 days carotene feeding	1548	5	2.3	85.8	103.4	17.6	
Last 4 days of depletion period	1709	9	3.5	107.6	124.3	16.7	
First 4 days carotene feeding	1709	5	3.5	82.6	88.4	5.8	
Second 4 days carotene feeding	1709	4	3.5	89.7	90.2	0.5	260
Third 4 days carotene feeding	1709	4	3.5	89.0	103.7	14.7	
Last 4 days of depletion period	1711	6	3.8	109.0	124.6	15.6	
First 4 days carotene feeding	1711	6	3.8	92.8	111.0	18.1	
Second 4 days carotene feeding	1711	4	3.8	81.0	96.5	15.5	240
Third 4 days carotene feeding	1711	7	3.8	88.5	105.7	17.2	

feeding since there was a very slight increase in the vitamin A potency of their milks. The milk from Holstein cow No. 1709 during periods II and III actually showed a decrease in vitamin A content.

A wide difference in vitamin A potency is noted between the four milks studied. The milk from cow No. 1546 contained the greatest amount of

vitamin A, approximately 453 units per quart, while the milks from cows Nos. 1548, 1709, and 1711 contained approximately 401, 261, and 242 vitamin A units per quart, respectively.

The data obtained in the above studies agree with the findings of Fraps and coworkers (10), who reported that the feeding of 116,000 rat units (?) of vitamin A per day is not sufficient to maintain the vitamin A potency of butterfat. Baumann and Steenbock (8) reported that the feeding of 50 to 60 pounds of freshly cut green alfalfa daily caused the carotene and the vitamin A content of the butterfat to increase rapidly. This alfalfa contained approximately 1,000,000 (?) units of vitamin A and caused the milk to contain maximum values for both carotene and vitamin A within a two weeks' period. A paper by Loy, Hilton, Wilbur and Hauge (11) appeared just subsequent to the preparation of this manuscript. These authors draw the conclusion that it takes from 10 to 11 days for the milk fat of the cow to reach its vitamin A equilibrium when the animal is shifted from a vitamin A rich diet to a vitamin A poor diet, and vice versa. With these conclusions in mind, the data of the present study would seem to indicate that 150,000 A.D.M.A. units per day were only sufficient to maintain constant the vitamin A potency of milks of cows receiving a pigment poor diet. If these cows had been fed this amount of carotene for a longer period of time, milk with a higher vitamin A potency might have been produced.

IV. The vitamin A potency of milks produced by five standard dairy breeds under identical feeding conditions

In the previous studies, wide variations in vitamin A potency of milks were noted among individual cows of the same breed. To partially compensate for such individual variations within the breed, ten cows from each breed were chosen as experimental subjects in this phase of the investigation. These cows were selected and handled in a manner similar to those previously described.

Table V portrays a record of the average food consumption and milk production for the five breeds of cows used in these studies.

TABLE V

The average food consumption and milk production for the five breeds of cows used in this study

BREED	GRAIN CONSUMED DAILY	SILAGE CONSUMED DAILY	HAY CONSUMED DAILY	MILK PRODUCED DAILY	FAT PRODUCED DAILY	PER CENT FAT
	lbs.	lbs.	lbs.	lbs.	lbs.	
Holstein . . .	11.9	29.5	8.3	39.2	1.403	3.57
Jerseys . . .	7.1	20.8	8.3	18.6	1.146	6.15
Guernseys . . .	7.9	22.3	8.3	22.0	1.178	5.35
Ayrshires . . .	10.9	27.5	8.3	32.4	1.264	3.90
Brown Swiss .	10.3	28.6	8.3	30.0	1.154	3.84

Pooled samples of milk from each of the breeds were taken daily for the purpose of biological assay. These pooled samples consisted of equal volumes of milk from each cow of the group during each of the milking periods. Measured aliquots of the pooled samples of milk from each of the breeds were fed to the experimental animals on the same day they were taken.

The results of the experiment relating to the vitamin A potency of milks produced by representative cows from five major dairy breeds (Table VI) indicate that there is an appreciable difference in vitamin A activity of the milk produced by Holstein, Brown Swiss, Ayrshire, Guernsey, and Jersey cows when maintained under identical nutritive conditions. These results are not in agreement with those of Davis and Hathaway (3) who concluded that there was no difference in vitamin A content of milk produced by different breeds under identical nutritive conditions.

Data obtained in this experiment indicate that there was no appreciable difference in the vitamin A activity of milk fat produced by the different breeds. These results are in agreement with those reported by Wilbur, Hilton, and Hauge (5) who concluded that there was no difference in vitamin A content of milk fat produced by Guernsey and Ayrshire cows.

CONCLUSIONS

(1) A study of the vitamin A potency of milk from Guernsey and Holstein cows receiving a normal dairy ration showed that individual variations occur within the breed, as well as between the breeds. In general, milks produced by Guernsey cows were higher in vitamin A than milks produced by Holstein cows.

(2) The vitamin A content of milks from Guernsey and Holstein cows which received a pigment-poor ration decreased approximately 70 per cent in seven months. The two breeds of cows responded quite uniformly in this regard under these adverse feeding conditions.

(3) When the cows, depleted of their vitamin A reserves, were subjected to high carotene feeding for a period of twelve days, the administration of 150,000 A.D.M.A. units per day was found to be insufficient to cause an increase in the vitamin A potency of the milks produced by the cows of either breed.

(4) Milks from groups of cows representing five major dairy breeds which were fed the same ration varied in vitamin A activity per unit volume. The vitamin A potency per gram of milk fat, however, was approximately the same for all breeds.

(5) It is concluded that the vitamin A potency of milks from the various dairy breeds is proportional to the percentage of milk fat characteristic of the breed.

TABLE VI

The vitamin A potency of milks produced by representative cows from five major dairy breeds

BREED	NUMBER OF RATS	DOSE CC.	WEIGHT OF RATS AT END OF FORE PERIOD GMS.	WEIGHT OF RATS AT END OF EXPERI-MENT GMS.	GAIN IN WEIGHT GMS.	DAILY GAIN PER GRAM OF MILK FED	VITAMIN A UNITS PER QUART	VITAMIN A UNITS PER GRAM OF FAT (SHERMAN)
Holstein	7	0.6	97.1	109.0	11.9	0.70	1699	20
Holstein	16	1.0	108.0	135.4	27.4			
Brown Swiss	10	0.6	112.0	136.2	24.2	1.00	1980	25
Brown Swiss ..	17	1.0	108.0	139.9	31.9			
Ayrshire	11	0.6	113.2	137.2	24.0	1.04	2157	26
Ayrshire	15	1.0	114.4	149.1	34.7			
Guernsey	10	0.6	102.6	128.4	25.8	1.23	2708	22
Guernsey	13	1.0	107.6	151.2	43.6			
Jersey	14	0.6	112.4	139.0	26.6	1.39	3212	22
Jersey	14	1.0	99.5	151.2	51.7			

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MANAGEMENT AND BREEDING DATA ON A DAIRY HERD IN WHICH BANG'S DISEASE (INFECTIOUS ABORTION) WAS ERADICATED BY SEGREGATION

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INTRODUCTION

Bang's disease (infectious abortion) was very seriously interfering with progress in the breeding and nutritional investigations being carried on with the dairy herd at Beltsville, Md., by the Bureau of Dairy Industry, United States Department of Agriculture, during the years 1921 to 1926. In that period there were 336 normal calvings and 95 abortions in the herd. Between January 1 and May 10, 1926, the disease became much more serious. In this period there were 21 normal calvings and 16 abortions. It was then decided to attempt to eradicate or control the disease by segregating the infected animals.

PROCEDURE

The herd was divided into two groups on May 10, 1926, according to the results of the agglutination test for the abortion disease. The abortion-positive animals were moved to new buildings one-half mile from the home buildings where the abortion-negative cows were held.

The home barns and yards were thoroughly cleaned and disinfected, all litter, ropes, implements, cattle, and other movable objects being removed from the stables to facilitate the work. The floors, walls, windows, doors, stanchions and mangers were soaked with water to loosen the dirt and hot water and soap were used in scrubbing the stables. This was followed by a thorough rinsing, then a disinfectant was applied with a force pump. Before the abortion-negative cows were placed in clean stables their bodies, legs, and feet were cleaned of straw, manure, and dirt. The surface of the cowyards was scraped and the scrapings were hauled away. All implements that could not be sterilized with steam were moved to the new buildings for use with the abortion-positive group and new ones were obtained for use in the abortion-negative group.

One crew of attendants cared for the abortion-negative group and another crew cared for the abortion-positive group. The people in charge of experiments, and others who of necessity had to visit the abortion-positive group, had a change of clothing and shoes which they used in order to avoid carrying the abortion infection to the home buildings.

The milk from the abortion-positive group was brought to the main building and handled in the same processing room as the milk from the abortion-negative group. The milk from the abortion-positive group was not fed to any animals on the farm except as stated in the following paragraph. Manure from the abortion-positive group was taken to cultivated fields only.

At first, the calves born in the abortion-positive group were brought to the home farm as soon as convenient. They were kept in one end of the calf barn until they were 3 months old, when they were placed with other calves in the negative group. Apparently, however, abortion infection was being carried to the negative group by this method of handling the calves. Thereafter the following plan of handling calves was adopted, and was carried out successfully. Calves born in the abortion-positive group were placed in a calf shed on the abortion-positive farm. They were fed milk from the abortion-positive cows until they were 50 to 60 days old. Then they were fed milk from the abortion-negative cows for 10 days, after which they were cleaned free of straw, manure, and dirt, and brought to the home buildings where they were kept separate for 10 days, and then added to the calf herd in the abortion-negative group. There was no evidence of abortion disease being spread by this method of handling calves.

The bulls were kept at the home building. When a bull was to be mated with an abortion-positive cow, he was taken to neutral ground near the abortion-positive quarters. As soon as the mating materialized, the bull was led away and no animals were allowed to approach the place of breeding until another mating. Cows in both groups were mated with the same bulls but the abortion-negative cows were bred at the home buildings. Only animals with apparently healthy genital organs were mated, therefore the bulls were not treated or disinfected in any way before or following matings. No evidence of spreading abortion disease by this manner of mating could be established.

Animals Segregated

When the initial separation was completed the abortion-negative group consisted of 65 females of breeding age and the abortion-positive group contained 82 females of breeding age. The number of animals added to the abortion-positive group from time to time is shown in Table 1.

Some of the animals in the negative group that reacted during 1926 (See Table 1, Column 1) may have been infected before the herd was divided. Eight cows may have become infected by coming in contact with manure from calves brought from the abortion-positive group. These cows had followed the manure spreader in a pasture and nosed the manure that fell to the ground. All of them reacted to the agglutination test a month later. This observation caused the change in the plan of handling the calves born in the abortion-positive group, as mentioned before. Carelessness in the

TABLE 1

Intervals at which the agglutination test was applied to the abortion-negative group, and the number of cows that became positive and that were added to the positive group each year (from May 11, 1926, to October 4, 1935)

	5-11-26 TO 5-10-27	5-11-27 TO 5-10-28	5-11-28 TO 5-10-29	5-11-29 TO 5-10-30	5-11-30 TO 5-10-31	5-11-31 TO 5-10-32	5-11-32 TO 5-10-33	5-11-33 TO 5-10-34	5-11-34 TO 5-11-35	5-11-35 TO 10-1-35	TOTAL
Interval at which the negative group was tested.* (days)	60	60	180	60	60	60	30	30	30	60	
Cows becoming positive that were added to the positive group.** (number)	24	0	14	3	8	28	2	1**	0	0	80

* All of the serological and bacteriological work in connection with abortion disease in the herd was done by the Bureau of Animal Industry at its animal disease station.

** This animal was born of an abortion-positive dam and continued to be positive until past breeding age.

testing of milk from the abortion-positive cows in one of the abortion-negative barns may have been responsible for the outbreak in 1928–29. An actual abortion in the negative group kept the infection active for some time. The large number of animals becoming positive in 1931 (See Table 1, Columns 5 and 6) was due probably to the infection being carried by people coming in contact with both groups. Due to the fact that the construction of buildings made it necessary for cows to calve in communicating stalls and small yards near the barns at this particular time, the infection was kept active. The outbreak stopped when more strict supervision over communication between the two groups was put in force and when the cows calved in the maternity barn again, and were held there until they passed a negative blood test. No cows or calves have become positive since June, 1932. One calf that was born previous to that time, however, has continued positive to maturity.

DISPOSAL OF ANIMALS

The experiments to which the cows were assigned before the herd was divided were continued in each group. Some of the cows died and others were disposed of when they no longer were needed in the experiments. Forty-seven females were added to the abortion-negative group, in addition to the female offspring of both groups and by January 1, 1936, the negative group had increased to 262 abortion-negative females of breeding age. Part of these 262 females of breeding age are the offspring of the progeny of the original groups of cows. The abortion-positive group gradually became smaller with the disposal of the animals as they became unfit for further use or were no longer needed for experimental work. The last of these animals was disposed of October 4, 1935. Table 2 shows the number of animals disposed of each year while the two groups were maintained.

FERTILITY

In this report the term fertile is used to designate females that conceived, regardless of whether or not they produced normal live calves. The breeding efficiency of cows is determined by finding the percentage of the females actually bred that conceived.

The 65 animals remaining in the initial abortion-negative group were bred for 213 pregnancies and 191 conceptions occurred, representing an average breeding efficiency of 89.67 per cent. The 82 abortion-positive cows that were moved to new quarters when the initial separation was made, were bred for 296 pregnancies and 269 conceptions occurred, representing an average breeding efficiency of 90.87 per cent. The 80 animals subsequently added to the abortion-positive group were bred for 261 pregnancies and 229 conceptions occurred, representing an average breeding efficiency of 87.73 per cent. The total number of 162 abortion-positive animals were bred for 557 pregnancies and 498 conceptions occurred, representing an average

TABLE 2

Number of females disposed of from the various groups each year from May 11, 1926, to October 4, 1935

GROUP, AND NUMBER OF FEMALES	5-11-26 TO 5-10-27	5-11-27 TO 5-10-28	5-11-28 TO 5-10-29	5-11-29 TO 5-10-30	5-11-30 TO 5-10-31	5-11-31 TO 5-10-32	5-11-32 TO 5-10-33	5-11-33 TO 5-10-34	5-11-34 TO 5-10-35	5-11-35 TO 10-4-35	TOTAL
Initial negative group (65 cows)	22	5	6	1	8	5	6	3	8	1	65
Initial positive group (82 cows)	17	9	9	9	11	10	6	3	6	2	82
Transfers from negative to positive group (80 cows)	3	2	4	3	8	10	12	11	18	10	80
Total positive females (162)	20	11	13	11	19	20	18	14	24	12	162
Total disposal, all groups	42	16	19	12	27	25	24	17	32	13	227

breeding efficiency of 89.40 per cent, while in the positive group the 80 cows that were transferred from the negative to the positive group had a lower average breeding efficiency than either of the initial groups, but the average for all positive animals was about the same as that for all the negative animals. Apparently the abortion disease in this herd did not lessen the fertility of the infected animals.

SERVICES REQUIRED FOR CONCEPTION

Table 3 shows that the average number of matings required for a conception in the two initial groups was similar. The initial abortion-negative group contained 14 heifers that averaged 4.14 matings for a first conception as compared with 2.82 for cows in the same group. In the initial abortion-positive group 11 heifers averaged 4.54 matings for a first conception as compared with 2.51 for cows in the same group. The larger number of services required for heifers than for cows raised the average number of matings for a conception in both initial groups. The 80 animals subsequently added to the abortion-positive group required a higher average number of matings for a conception than either of the initial groups.

DISTRIBUTION OF SERVICES

Approximately 31 per cent of the conceptions among the cows that were added to the abortion-positive group resulted from the first mating as compared to 36 and 40 per cent in the two initial groups. (See Table 4.) This table shows for the four groups of cows (the fourth group being the second and third groups combined) the number of animals bred 1 to 10 or more times for each conception. In the first group, 213 cows were bred and 77, or 36.15 per cent, conceived at the first mating. This left 136 to be bred two or more times. On the second service 39, or 28.67 per cent of the 136 animals conceived leaving 97 to be bred three or more times. On the third mating in this group one cow was removed because she was thought to be permanently sterile and 19 conceived. All cows were examined before breeding and those requiring four or more services were examined again for abnormalities of the genital organs. Of the fertile cows in the initial abortion-negative group 81 per cent conceived on the first to the fourth mating and the others were bred five or more times for a conception. In the initial abortion-positive group 81 per cent conceived on the first to the fourth mating, and in the group of animals added to the initial abortion-positive group 76.95 per cent conceived on the first to the fourth mating. The largest number of animals discarded because of permanent sterility came from the group that was added to the initial abortion-positive group, the number being 31, or 38.75 per cent, while in the two initial groups the numbers were 21, or 32.21 per cent, and 25, or 30.43 per cent. It should be added, however, that in the initial abortion-positive group some animals

TABLE 3

Average number of services required for a conception by fertile females in the different groups, and the results of pregnancies
(from May 11, 1926, to October 4, 1935)

GROUP, AND NUMBER OF FEMALES	TOTAL CONCEPTIONS			RESULTS OF PREGNANCIES								
				Live calves			Calves born dead			Abortions		
	Number	Services		Number	Services		Number	Services		Number	Services	
		Total	Average		Total	Average		Total	Average		Total	Average
Initial negative group (51 cows and 14 heifers)	191	558	2.92	157	456	2.90	16	53	3.31	15	43	2.86
Initial positive group (71 cows and 11 heifers)	269	798	2.96	196	556	2.93	19	62	3.26	41	117	2.85
Transfers from negative to positive group (80 cows)	229	754	3.29	134	428	3.19	18	75	4.16	71	241	3.39
Total positive females (162)	498	1,552	3.11	330	984	2.98	37	137	3.54	112	358	3.19

TABLE 4

Number and percentage of females in each group that conceived after being bred from 1 to 30 times, and the number and percentage that were discarded as sterile

(1926–1935)

NUMBER OF TIMES BRED	FEMALES IN INITIAL NEGATIVE GROUP					FEMALES IN INITIAL POSITIVE GROUP					FEMALES TRANSFERRED FROM NEGATIVE TO POSITIVE GROUP					TOTAL POSITIVE FEMALES				
	Bred	Conceiving		Discarded as sterile		Bred	Conceiving		Discarded as sterile		Bred	Conceiving		Discarded as sterile		Bred	Conceiving		Discarded as sterile	
	number	number	per cent	number	per cent	number	number	per cent	number	per cent	number	number	per cent	number	per cent	number	number	per cent	number	per cent
None	0	0	0.00	0	0.00	0	0	0.00	2	0.00	0	0	0.00	3	0.00	0	0	0.00	5	0.00
1	213	77	36.15	0	0.00	296	119	40.20	1	0.33	261	82	31.41	1	0.38	557	201	36.08	2	0.35
2	136	39	28.67	0	0.00	176	48	27.27	0	0.00	178	43	24.15	1	0.56	354	91	25.70	1	0.28
3	97	19	19.58	1	1.03	128	39	30.46	2	1.56	134	27	20.14	1	0.74	262	66	25.26	3	1.14
4	77	21	27.27	3	3.89	87	14	16.09	3	3.44	106	25	23.58	2	1.88	193	39	20.20	5	2.59
5	53	7	13.20	0	0.00	70	17	24.28	2	2.85	79	19	24.05	2	2.53	149	36	24.16	4	2.68
6	46	11	23.91	4	8.69	51	7	13.72	0	0.00	58	7	12.06	1	1.72	109	14	12.84	1	0.91
7	31	6	19.35	1	3.22	44	4	9.09	4	9.09	50	9	18.00	3	6.00	94	13	13.82	7	7.44
8	24	5	20.83	0	0.00	36	6	16.66	2	5.55	38	5	13.15	1	2.63	74	11	14.86	3	4.05
9	19	2	10.52	1	5.26	28	5	17.85	0	0.00	32	3	9.37	3	9.37	60	8	13.33	3	5.00
10	16	0	0.00	1	6.25	23	2	8.69	1	4.34	26	3	11.53	1	3.84	49	5	10.20	2	4.08
11–20	15	5	33.33	8	53.33	20	8	40.00	8	40.00	22	6	27.27	15	68.18	42	14	33.33	23	54.76
21–30	2	0	0.00	2	100.00	4	2	50.00	2	50.00	1	1	100.00	0	0.00	5	3	60.00	2	40.00

were discarded early in life, for various reasons, that might have become sterile if kept longer. Diagnosis of permanent sterility was made only when the animals were slaughtered and the genital organs carefully examined.

NUMBER OF MATINGS FOR CONCEPTION AFTER A NORMAL CALVING AND AFTER AN ABORTION

The data presented in Table 5 indicate that, in the abortion-positive group, more matings were required on an average for a conception after an abortion than after a normal calving. In the abortion-negative group the average number of services for a conception was somewhat less after an abortion than after a normal calving, though the number of cases in the abortion-negative group in which conception followed an abortion is rather small. Since the abortions in the abortion-negative group were not due to *Brucella abortus*, and since most of the abortions in the abortion-positive group were, these results may indicate that abortions caused by *Brucella abortus* are more harmful to the genital organs than either full-term pregnancies or abortions due to other causes.

TABLE 5

Average number of services required for conception after a normal calving and after an abortion (from May 11, 1926, to October 4, 1935)

GROUP	BRED AFTER A NORMAL CALVING			BRED AFTER AN ABORTION		
	Total conceptions	Services		Total conceptions	Services	
		Total	Average		Total	Average
Initial negative group	131	388	2.96	12	28	2.33
Initial positive group	173	428.	2.47	30	98	3.26
Transfers from negative to positive group	101	295	2.92	53	168	3.16
Total positive females	274	723	2.63	83	266	3.20

The results of pregnancies were classed as live calves, calves born dead, abortions, and fetuses found on autopsies. When a calf was born alive, normally developed, able to stand and nurse its dam, it was designated as a living calf. All calves delivered which apparently were lacking in intrauterine development were termed abortions. This includes so-called premature calves that lived only a few hours after birth. All mummified fetuses were classified as calves born dead. Other calves were born dead after a gestation of normal length. The majority of these died during delivery. There is no great difference in the number of calves born dead in the different groups. The percentage of abortions among the animals that became

reactors after the original segregation is a little more than double that in the original group of abortion-positive cows. (See Table 6.) The cows that were added to the abortion-positive group from time to time also required a higher average number of matings for a conception than the original abortion-positive cows. (See Table 3.) Abortion due to *Brucella abortus* was at its peak of destruction in the herd about the time the herd was divided, as is shown by the number of abortions recorded in the introduction of this report. Many of the abortions just before the division of the herd were from young animals. At the time of testing and dividing the herd 28 of the older cows reacted to the agglutination test in dilutions of 1 part of serum to 50 parts of bacterial suspension or less, and 20 of the younger animals reacted in dilutions of 1 part of serum to 500 parts of the bacterial suspension or more, and the others reacted in dilutions of 1 part of serum to 100 parts of bacterial suspension or more. The animals that were added to the initial abortion-positive group from time to time apparently carried a newly acquired infection which reached its peak of virulency shortly after they were added to the reacting herd. Six of these animals reacted to the agglutination test in a dilution of 1 part of serum to 100 parts of bacterial suspension and all the others reacted in dilutions of 1 part of serum to 200 parts of bacterial suspension or more. The results indicate that the disease was more severe in newly infected animals, which accounts for the fact that the cows that were added to the abortion-positive group had more abortions and required more services for a conception than the cows in the initial positive group. Table 6 shows that the percentage of live calves was largest in the abortion-negative group and smallest among the animals that were added to the abortion-positive group from time to time.

Experiments were occasionally conducted in both the abortion-negative and abortion-positive groups that required the animals to be held open 5 to 8 months after freshening. This practice has some effect on the results of pregnancies, as shown in Table 7. Although the data in Table 7 cover the period during which the reactors and nonreactors were maintained in separate groups, they do not cover the entire life of many of the individual animals, since some of them were mature and some were old when the segregation was made. The same is true of the animals added to the abortion-positive group from time to time. For these reasons the average number of years the cows were in the herd, as shown in Table 7, Column 3, is low, though the average is about even in the different groups. Table 7 shows that the average number of pregnancies each cow-year was greater among the abortion-positive cows. This apparently was due to the shortened gestation periods brought on by the larger number of abortions among the abortion-positive animals. A truer value of the usefulness of the cows as breeding animals is indicated by the average number of live calves born in a cow-year. (See Table 7.) These averages indicate the cows added to the abortion-positive group were the least useful as breeding animals.

TABLE 6

Results of pregnancies in the different groups (from May 11, 1926, to October 4, 1935)

GROUP AND NUMBER OF FEMALES	TOTAL PREGNANCIES	LIVE CALVES		DEAD CALVES		ABORTIONS		FETUSES FOUND ON AUTOPSY	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
Initial negative group (65 cows) ...·....	191	157	82.19	16	8.37	15	7.84	3	1.51
Initial positive group (82 cows) .. .	269	196	72.86	19	7.06	41	15.24	13	4.83
Transfer from negative to positive group (80 cows)	229	134	58.42	18	7.92	71	31.00	6	2.62
Total positive females (162 cows)	498	330	66.26	37	7.42	112	22.48	19	3.81

TABLE 7

Data on cow-years and pregnancies in each group (1926-1935) (Cow-year is 12 months in this table)

GROUP AND NUMBER OF FEMALES	COW YEARS	AVERAGE NUMBER YEARS COWS IN HERD	TOTAL PREG- NANCIES	AVERAGE NUMBER PREG- NANCIES EACH COW	AVERAGE NUMBER PREG- NANCIES EACH COW-YEAR	NUMBER OF LIVE CALVES	AVERAGE NUMBER OF LIVE CALVES EACH COW-YEAR
Initial negative group (65 cows)	229.53	3.53	191	2.92	0.83	157	0.68
Initial positive group (82 cows)	308.75	3.76	269	3.28	0.87	196	0.63
Transfer from negative to positive group (80 cows)	263.55	3.29	229	2.86	0.86	134	0.50
Total positive females (162 cows)	572.36	3.53	498	3.07	0.87	330	0.57

SEX RATIO

The data in Table 8 present the number and sex of calves and fetuses during the 9 years 5 months the two groups were segregated. Both members of all twins of the same sex were tabulated and both members of mixed twins were omitted. Some fetuses were mutilated and the sex of others was not definitely observed, which accounts for those listed as of unknown sex. There were 21 sets of twins, 10 of them mixed twins, among the 689 pregnancies accounted for. The known sexes of aborted fetuses were 33 females and 47 males.

TABLE 8

Sex of calves and fetuses during 9 year 5 month period (May 10, 1926, to October 4, 1935)

GROUP AND NUMBER OF FEMALES	NUMBER OF FEMALE CALVES	NUMBER OF MALE CALVES	NUMBER OF SETS OF MIXED TWINS	NUMBER OF CALVES SEX UNKNOWN
Initial negative group (65 cows)	94	90	5	7
Initial positive group (82 cows)	106	138	3	23
Transfer from negative to positive group (80 cows)	100	106	2	24
Total positive females (162 cows)	206	244	5	47

SUMMARY

Initial division of the herd was made on May 10, 1926, according to the results of the agglutination test for Bang's disease (infectious abortion).

The abortion-negative group consisted of 65 females of breeding age and the abortion-positive group 82 females of breeding age. The 82 reactors were moved to new buildings, about one-half mile from the home buildings, where the 65 nonreactors were held. From May 21, 1926, to June 18, 1932, 80 cows from the abortion-negative group were added to the abortion-positive group. The abortion-positive group was terminated October 4, 1935.

Mere division of the herd was not effective in preventing the spread of the disease. Strict supervision of all communication between the two groups stopped the spread of the disease. Different crews cared for the different groups of animals. The milk from the two groups was handled in the same room at the home buildings.

Calves born in the abortion-positive group were fed milk from that group until they were 50 to 60 days old, then changed to milk from the abortion-negative group for 10 days, after which they were taken to the home buildings and isolated for 10 days before being placed with the other calves in the abortion-negative group.

The same bulls were bred to abortion-negative and abortion-positive cows without evidence of their spreading the disease.

The group of 80 cows added to the abortion-positive group from time to time required more services for a conception than any other group, and the percentage of conceptions resulting from the first four services was smaller in this group than in any other. The percentage of pregnancies terminating in live calves was also smaller in this group than in any other group. This group was also less efficient than the other groups, as judged by the average number of live calves per cow-year. The less favorable showing of these 80 cows was probably due to the fact that they became positive and went through the most serious phase of the disease during the period covered by these data, while many of the animals in the original positive group had already passed through the most serious phases of the disease prior to segregation and were not so seriously affected during the period covered by these data.

The abortion-positive cows required more services for a conception when bred after an abortion than when bred after a normal calving.

The sex of calves and fetuses is given for the time the abortion-positive group was maintained.

THE ELECTROKINETIC POTENTIAL OF MILK FAT[1]

I. GENERAL ELECTROPHORETIC STUDIES

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INTRODUCTION

It has been known for many years that milk fat globules are electrically charged. The explanations offered to account for some dairy phenomena have been based wholly, or in part, upon this fact, but few quantitative data have been presented to substantiate the theory. This study was undertaken to secure information regarding the magnitude of the potential under normal conditions and the effect of various agents upon it; the correlation between changes in the magnitude of the potential and certain known behaviors of fat globules under conditions of usual commercial dairy practice; and the nature of the interface between the fat globule and the surrounding medium as revealed by studying alterations in the potential.

HISTORICAL

Abramson (1) has compiled an excellent summary of the theoretical and practical development of the general field of electrokinetics. In specific relation to milk fat Jürgenson (2) in 1860 was probably the first to note the migration of milk fat globules in an electrical field. He observed that the globules moved toward the positive pole and concluded that they were negatively charged. Sirks (3) found that the potential at the fat globule milk plasma interface was of a low order of magnitude and he was unable to correlate it with any dairy phenomena.

Mommsen (4) found the isoelectric point of fat globules in cream to be pH 4.17. Additions of gelatin caused a shift to the isoelectric point of gelatin. Prieger (5) reported that the isoelectric point of milk fat emulsified in distilled water was on the acid side of that found in a milk emulsion.

Mohr and Brockmann (6) report the isoelectric point of milk fat globules to be pH 4.3 in an acetate buffer. At this pH the exhaustiveness of churning of cream was found to be most pronounced. Heating and homogenization, they claim, had no effect on the position of the isoelectric point. They found that there was no apparent relation between the mobility of the fat globules and surface tension or viscosity but that the addition of casein brought the isoelectric point to pH 4.44.

North and Sommer (7) have presented a method of streaming potential measurements adapted to milk fat. They found that the magnitude of the measurements was a function of the temperature. The potential was found to be negative and the isoelectric point in the region of pH 4.3. Added salts affected the potential: phosphate and citrate ions increased the potential while calcium, ferric, and thorium ions decreased it. These authors report a variation in potential as great as fifty per cent when skim milk from different individual cows is streamed through a milk fat capillary.

EXPERIMENTAL PROCEDURE

There are three methods available for measuring electrokinetic potentials: electrophoresis, the streaming potential method, and electroendosmose. These have been compared by Bull (8) who found them to give practically identical values. After a critical consideration of the system to be studied and an analysis of the factors affecting changes in this system, the method of electrophoresis was chosen.

The mathematical expression relating electrophoretic mobility of a charged particle to its zeta potential has been developed by Schmoluchowski (9). It shows that

$$\zeta = \frac{4\,\pi\,\eta\,v}{E\,\epsilon}$$

where ζ is zeta potential, v is the velocity of migration of the particle, η is the absolute viscosity, E is the voltage applied per unit distance between electrodes, ϵ is the dielectric constant. Recently, Debye and Hückel (10) have contended that the factor *four* should be *six* for particles of a particular size and shape.

The electrophoretic apparatus used in this work was the Mudd Modification of the Northrup-Kunitz cell (11). This has been described in detail by Moyer (12). An E.M.F. of 135 volts from three radio "B" batteries was used. The microscopic equipment consists of a microscope equipped with a 21 × objective having a working distance of 1.8 mm. and a 25 × ocular. The light source was from a micro-lamp and the light was filtered through a copper sulphate solution. The distance traversed by the migrating particles was measured on a calibrated ocular micrometer and the elapsed time noted by means of a stop-watch.

A measurement consisted of noting the time necessary for a globule to pass a standard number of micrometer spaces. Measurements were made at 0.21 and 0.79 of the depth of the cell at which points it has been shown that actual electrophoretic velocities are obtained. Because of the opaque character of the milk, dilution was necessary. The standard procedure of diluting with 200 parts of distilled water was adopted after preliminary trials had shown that dilution in the range of 1:100 up to 1:800 was without effect on the mobility. Five measurements were made at 0.21 depth

with the current flowing in one direction, the current was then reversed and five measurements were made in the opposite direction after which the microscope was focused at the 0.79 depth and ten more measurements were made as noted above. The average of these twenty readings was used to calculate the mobility in terms of micra per second per volt per centimeter, considering the distance traversed, the E.M.F. applied, and the potential drop across the cell.

The cell was previously standardized according to directions supplied by the manufacturer.

<div align="center">EXPERIMENTAL DATA</div>

The Effect of Temperature

The fundamental equation given above relating electrophoretic mobility to zeta potential indicates that the magnitude of the potential is not affected by changes in temperature. To determine the effect of temperature upon the mobility, measurements of mobility were made over a temperature range from 15° C. to 30° C.

<div align="center">TABLE 1</div>
<div align="center">The effect of temperature on electrophoretic mobility</div>

TEMPERATURE	MOBILITY
°C.	μ/sec./v/cm.
15.0	1.98
20.0	2.30
22.5	2.42
25.0	2.56
28.8	2.76
30.0	2.83

The percentage change in mobility, as shown in Table 1, is two per cent per degree at 25° C. and corresponds to the viscosity change in water in this temperature range. Moyer (12) also has shown that this relationship is true. With this fact in mind all values were corrected to 25° C.

<div align="center">TABLE 2</div>
<div align="center">Electrophoretic mobility according to breed of cows</div>

BREED	APPROX. DIAMETER OF GLOBULES	MOBILITIES
	Micra	μ/sec./v/cm.
Holstein-Friesian	3.0	2.56
Ayrshire .	3.5	2.53
Guernsey	5.0	2.53
Jersey	6.0	2.51
Brown Swiss ..	4.0	2.55

The Effect of Breed of Cows

Electrophoretic mobilities of fat globules from cows of each of the five major dairy breeds were determined by the method previously outlined. The differences, reported in Table 2, were not considered significant.

The Isoelectric Point of Milk Fat

Measurements of mobilities were made at different pH values in an acetate buffer and in a citrate buffer. The curves obtained are shown in Figure 1.
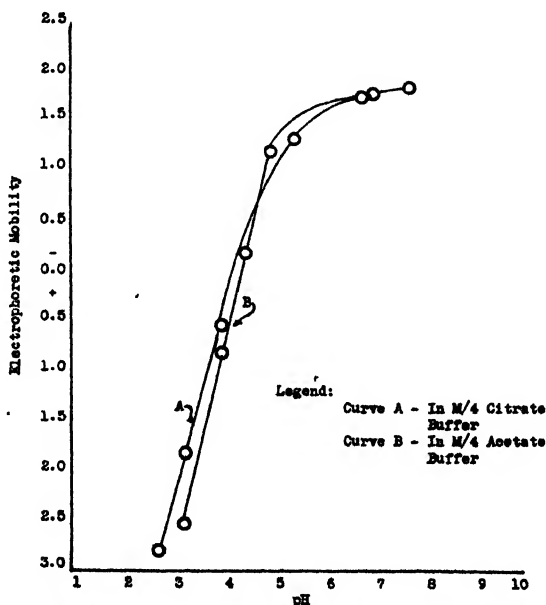
FIG. 1. THE ISOELECTRIC POINT OF FAT GLOBULES IN DIFFERENT BUFFERS

Each curve has a different slope but both show the same point of zero mobility of fat globules at pH 4.3. This is in agreement with the results obtained by Mohr and Brockmann and by North and Sommer cited previously.

The Effect of Added Salts

Salts yielding ions of different valences were used to note the effect upon the mobility of the fat globules. In one series potassium, calcium, ferric and thorium ions were added as chloride salts in equal chloride ion concentration; in the other series, the sodium salts of secondary phosphate and citrate were added in equal sodium ion concentration. The effect upon the mobility of the fat globules is shown in Figure 2.

The trend of these data is similar to the results reported by North and Sommer (7) using a streaming potential method.
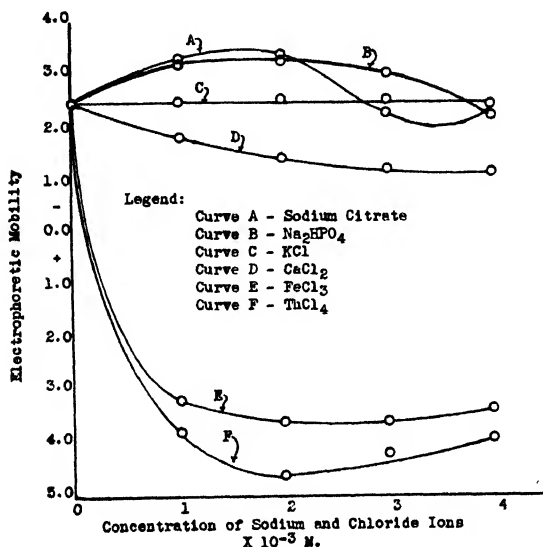
FIG. 2.   THE EFFECT OF ADDED SALTS

DISCUSSION OF RESULTS

It is impossible to say what effect the dilution of milk by 100 parts of water has upon the mobility of the fat globules. The fact that further dilution has no effect suggests the possibility that the potential of the fat globule results from ionization of adsorbed materials rather than from adsorption of ions since dilution would decrease the concentration of ions and alter the mobility.

The significance of the isoelectric point lies in the fact that it indicates something as to the nature of the substances present at the surface of the globules.   The isoelectric point of casein is given as pH 4.6 (13) and that of whey proteins is given by Okuda and Zoller (14) as pH 4.5.   Data to be presented later show that milk phospholipids have their isoelectric point at pH 2.0.   This evidence indicates that the surface layer of the fat globules is essentially protein but that some other material with a lower isoelectric point, undoubtedly a phospholipid, is also present.

SUMMARY AND CONCLUSIONS

An electrophoretic method for studying the electrokinetic potential of milk fat is described. Results are expressed as electrophoretic mobilities considered proportional to the electrokinetic potential.

Dilution of milk within the range of 1:100 to 1:800 had no effect on the mobility.

Changes in temperature resulted in like changes in mobility equal to two per cent per degree centigrade at 25°.

There was no significant difference in mobility of fat globules from cows of different breeds.

The isoelectric point of fat globules was found to be pH 4.3 in acetate and citrate buffers.

Additions of salts resulted in changes in mobility in accordance with the valence and sign of the ions furnished by the salts.

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OBSERVATIONS ON THE CAROTENE CONTENT OF SOME TYPICAL PASTURE PLANTS[1]

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A PRELIMINARY REPORT

Only in recent years has vitamin A been considered a limiting factor in the well-being of cattle under ordinary feeding conditions. Hart and Guilbert (8) reported evidence of vitamin A deficiency in range cattle after unusually prolonged dry feeding periods. Results such as reproductive failure, and dead, weak or sick calves were more common when the feed was ample, and complete except in vitamin A potency. They concluded (6) that the storage of vitamin A during the green feed season is sufficient to carry range animals safely through the dry-feed periods of ordinary duration. In discussing dairy cattle feeding, Woodward and Nystrom (15) state that vitamin A is the vitamin most likely to be deficient.

Meigs and Converse (11, 12) reported that in the case of liberally milking cows the ration is likely to be deficient in vitamin A if it consists of grain, silage and hay without pasture, unless good quality hay is generously fed. Calves could not be successfully raised on milk produced from rations based on poor quality hay. Converse and Meigs (2) have shown that in raising calves on restricted quantities of whole milk the limiting factor is the vitamin A content of the butter fat rather than any other inherent qualities of the fat.

Ample evidence is available (1, 5, 9, 10, 13) showing that the vitamin A potency of butter is largely dependent on the ration consumed by the cows. Butter with high vitamin A content is important in human nutrition.

Considering the large percentage of dairy cows fed on poor quality roughage, perhaps the pasture feeding period may be the balance wheel in the entire year's feeding program. Without the annual pasturage season, many ill effects might result.

Dutcher (4) states that the vitamin content of leafy plants and vegetables may be correlated with greenness, metabolic activity, and maturity, the old mature tissues tending to be less valuable sources of vitamin A than young rapidly metabolizing tissues. Virtanen (16) reported that the proportions of carotene (the precursor of Vitamin A) in plants are higher the better the plant grows, attaining a maximum before or at the beginning of flowering. He further stated that proper fertilization increases the carotene content, while factors which retard growth lowers the carotene content.

Coward (3) found that vitamin A is completely destroyed when the leaves of plants dry up, become brown, and die.

The importance of pasture as a source of carotene for dairy cows, the variety of plants used for pasture—either alone or in mixtures—and the

CAROTENE CONTENT OF SOME TYPICAL PASTURE PLANTS

1 BUFFALO GRASS
2 BIG BLUE STEM
3 LITTLE BLUE STEM
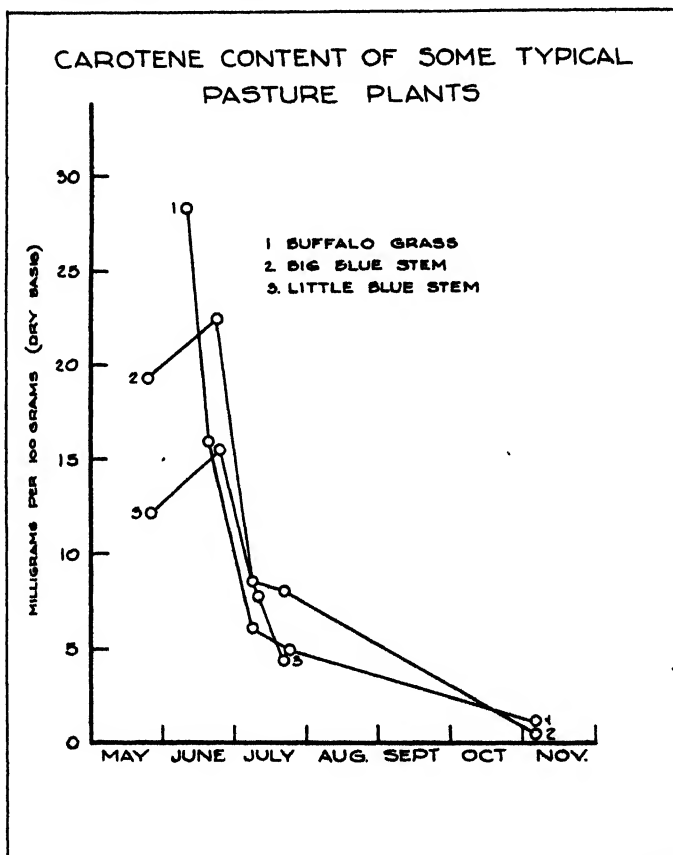
differences in the growth habits of pasture plants seemed to justify study of the carotene content of some of the common pasture plants at different periods in the year. The results presented are a preliminary report on such a study.

EXPERIMENTAL

Thirteen pasture plants, typical of those used for pasture purposes in Kansas, were selected for study. Samples were taken from pure stands maintained in Department of Agronomy plots. Sampling was done by grasping branches of grass in a manner similar to the way in which the cow might graze. The different plants varied in height from 6 to 15 inches at

TABLE I

Carotene content of some pasture plants at different periods throughout the growing season

DATE SAMPLE TAKEN	PASTURE PLANTS STUDIED	CAROTENE PER 100 G.		CAROTENE PER LB		MOISTURE
		Fresh	Dry	Fresh	Dry	
		mg.	*mg.*	*mg.*	*mg.*	*per cent*
5–22	Rye	5.5	25.1	25.1	114.0	82.3
11–28	"	8.4	30.6	37.9	138.8	72.7
5–23	Big blue stem	4.4	19.2	19.8	87.5	77.3
6–24	" " "	7.7	22.1	34.8	100.5	65.4
7–8	" " "	3.6	8.4	16.5	38.2	56.8
7–21	" " "	3.7	8.0	17.0	36.4	53.3
11–4	" " "	0.3	0.4	1.5	1.9	24.6
5–23	Canadian brome	10.4	53.3	47.0	242.0	80.6
7–11	" "	4.2	7.7	19.1	34.9	45.3
5–28	Kentucky blue grass	4.1	10.2	18.8	46.2	59.0
6–26	" " "	4.0	6.2	18.2	28.2	35.0
7–9	" " "	6.3	8.0	28.8	36.4	20.9
7–20	" " "	3.6	4.1	16.5	18.5	10.8
11–4	" " "	7.2	21.4	32.6	97.2	66.6
5–28	Little blue stem	3.8	12.2	17.2	55.2	68.9
6–28	" " "	6.7	15.6	30.5	70.8	56.9
7–8	" " "	4.5	8.1	20.4	36.7	44.5
7–21	" " "	2 7	4.3	12.3	19.7	37.8
6–10	Buffalo grass	12.6	28.2	57.2	128.1	55.4
6–23	" "	8.6	15.9	39.3	72.1	45.5
7–6	" "	4.4	6.0	19.8	27.2	30.2
7–20	" "	3.7	4.8	16.8	21.8	23.0
11–6	" "	0.7	0.9	3.0	4.2	29.3
6–10	Red top	4.0	11.3	18.2	51.3	64.0
6–22	" "	3.7	6.8	16.6	30.8	46.2
6–26	" "	3.4	5.4	15.3	24.4	37.4
11–6	" "	5.7	24.1	25.9	109.2	76.3
6–22	Alfalfa	8.8	29.2	39.7	132.6	70.7
7–6	"	8.0	22.2	36.4	100.6	63.8
7–22	"	3.2	8.3	14.7	37.6	60.9
11–6	"	7.1	14.3	32.1	64.9	50.5
6–23	Dakota brome	6.2	17.8	28.3	81.0	65.0
7–23	" "	3.8	6.6	17.4	30.0	42.2
11–4	" "	8.6	33.4	39.0	151.6	74.3
6–25	Local brome	7.1	15.6	32.0	71.0	54.9
7–11	" "	4.9	8.5	22.2	38.4	42.2
11–13	" "	6.6	16.7	30.1	75.6	60.2
6–25	Orchard grass	6.8	15.2	30.8	68.8	55.2
7–9	" "	6.4	12.2	29.0	55.4	47.7
7–22	" "	3.8	7.5	17.2	34.0	49.4
11–13	" "	6.4	15.4	29.2	69.9	58.3
11–28	Wheat	6.6	17.9	29.7	81.5	63.5
11–28	Barley	9.6	37.6	43.5	170.5	74.5

time of sampling.   The work might be criticized for not representing actual pasturage conditions as the plots were not grazed at any time.

After collection the samples were taken immediately to the laboratory and prepared for analysis by cutting as finely as possible with shears.
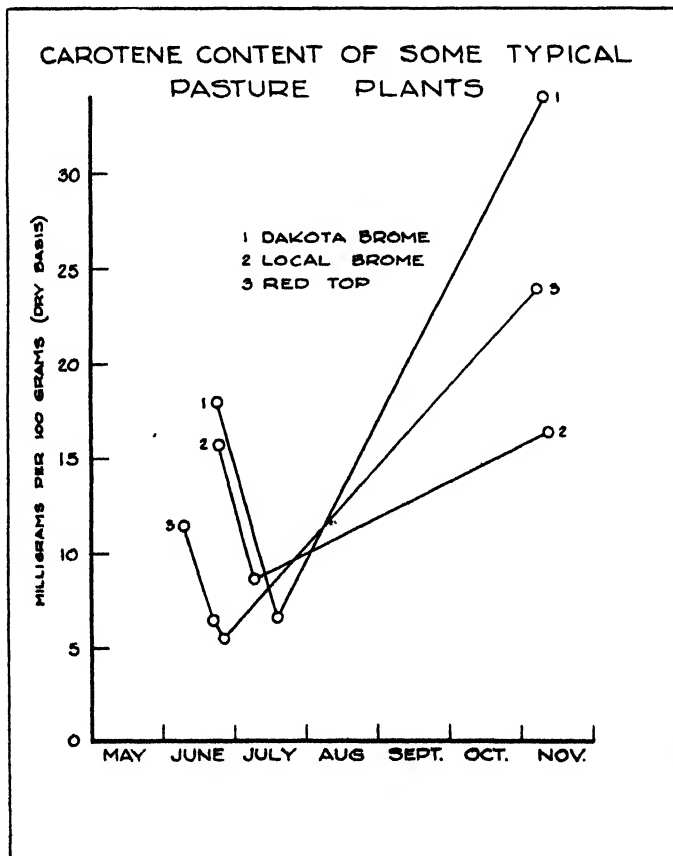
Analysis for carotene was made according to previously described technique (7, 14).   Facilities did not make it possible to sample all the plants on the same dates.

DISCUSSION OF RESULTS

All the pasture plants studied had a relatively high carotene content during the early summer.   Seven of the plants sampled between May 22 and June 10 showed a wide range in carotene content, varying from 17.2 mg. of carotene per pound on the fresh basis to 57.2 mg., or a difference of about 300 per cent.   Four of the plants—little blue stem (*Andropogon scoparius*),

big blue stem (*Andropogon furcatus*), Kentucky blue grass (*Poa pratensis*), and red top (*Agrostis alba*)—were quite similar, averaging about 18 mg. at that season of the year.
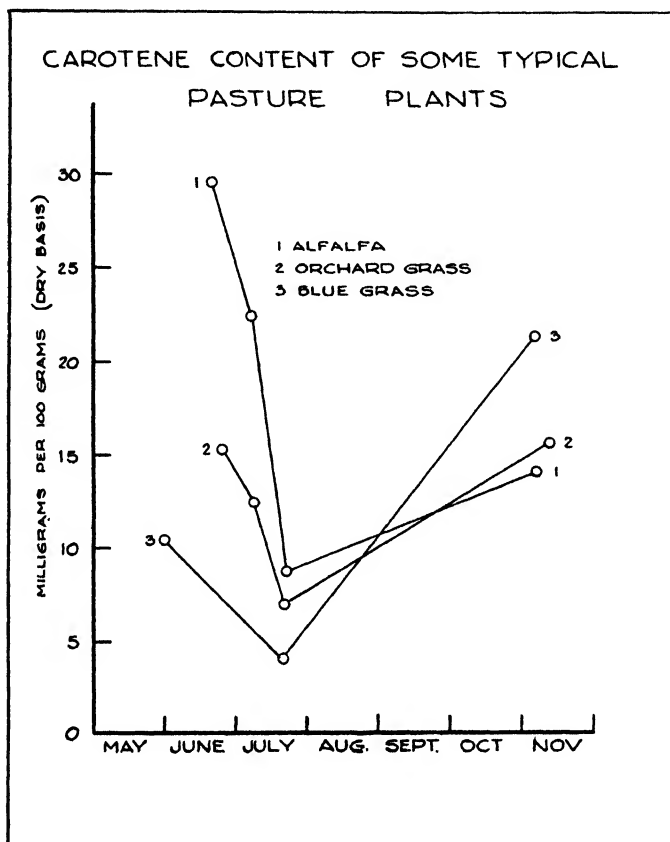
During midsummer (July) most of the plants markedly decreased in carotene content, the exceptions being alfalfa and Kentucky blue grass. The alfalfa represented new growth after a hay crop had been cut. That sample of blue grass was not typical of the conditions for the other plants since it was taken on the college lawn where the grass had been clipped and watered.

Samples taken in November showed very striking differences among the plants in their ability to renew growth and reestablish high carotene values after the fall rains had come. Big blue stem and buffalo grass (*Buchloe dactyloides*) remained brown and naturally cured and were practically devoid of carotene. Most of the other grasses had a carotene content approaching early summer values. These differences in recovery of carotene

content in late fall might be significant in live stock feeding, particularly when the fall grazing period is followed by a long winter feeding of rations low in carotene.

Although these results were obtained during a drought year general knowledge of the growth habits of the plants studied would lend credence to the data obtained.   Whether the same relative decrease in carotene during midsummer would prevail under pasturage conditions is problematical.

SUMMARY

All pasture plants studied showed relatively high carotene values in early summer, but with rather wide variations.   During the hot months of midsummer carotene content tended to decrease markedly.   After the fall rains most of the plants reestablished their carotene content similar to early summer values.   Notable exceptions were found in some plants which were practically devoid in carotene in the fall.

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USE OF ISOPROPYL ETHER IN A MODIFIED
MOJONNIER FAT TEST

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In recent years many solvents have been made commercially available which heretofore could only be procured in very small quantities at very high prices. While such solvents are now finding their place in the commercial field, apparently very little has been done in analytical laboratories toward adapting analytical methods to the use of these newer reagents. In many instances these products are cheaper and more satisfactory than the old solvents.

Of the low boiling solvents, ethyl ether is probably the one most widely used in chemical laboratories. Petroleum ether, or ligroin, has filled an important place in the laboratory as a fat solvent and reagent and in the analysis and purification of organic compounds. Both of these solvents however are highly volatile and because of their low boiling points and inflammability dangerous when stored under ordinary conditions of temperature.

In the analysis of dairy products both ethyl ether and petroleum ether are used in the Mojonnier method of fat extraction, which has become standard in most dairy laboratories. This method as described by Mojonnier and Troy is accurate but the problem of keeping the ether solvents is a real one. Their low boiling point (98° F.) requires that they be kept in hermetically sealed cans or in cold storage and even then the loss by evaporation is considerable. Also it will evaporate from Mojonnier measuring containers and considerable residue is accumulated from the rubber connections. One way to overcome these difficulties was to substitute for the ether a suitable solvent of relatively high boiling point. Of several solvents which were available isopropyl ether gave the most satisfactory results for use in the Mojonnier test.

Isopropyl ether is a colorless liquid of ethereal odor with a boiling point of 67.5° C.* The commercial product is soluble in water to the extent of

* *CAUTION:* In dry distilling any ether the possibility of an explosion at the end of the evaporation, due to the presence of peroxides, must be taken into account. Such ether will liberate iodine from an acid solution of potassium iodide and it is advisable to always make this test for peroxides. If found they should be destroyed by washing with a 10 per cent solution of sodium sulphite.

0.65% by volume at 25° C. while water is soluble in it to the extent of 0.025% at the same temperature. It is an excellent solvent for animal, vegetable, and mineral oils, also fats, waxes, and resins. Isopropyl ether is somewhat similar to ethyl ether in properties but does tend to form peroxides more readily than ethyl ether. Consequently the presence or absence of peroxides should be determined by the method mentioned in the footnote and if present, should be destroyed with sodium sulphite before distillation. Its boiling point is higher than that of ethyl ether and its vapor pressure lower, a decided advantage in extraction process. Furthermore, the low solubility of water in isopropyl ether is a distinct advantage in the determination of fats by the Mojonnier method. In the Mojonnier method of analysis isopropyl ether has a tendency to form an emulsion with water solutions but a perfect separation without the aid of a centrifuge is easily procured by the addition of alcohol to the water solution.

In the experimental trials fat determinations were made on milk, buttermilk, cream, sour cream, dry milk, evaporated milk and ice cream using isopropyl ether and the results compared with those obtained by the standard Mojonnier method using ethyl and petroleum ether. A slight modification was necessary in the amount of alcohol and water used with the isopropyl ether in the analysis of the different products. The results were excellent and in the analysis of certain products more accurate than when ether and ligroin were used due to the carrying over of milk solids by the ethyl and petroleum ether mixture.

PROCEDURE

Approximately 5 grams of the milk product are weighed directly in the Mojonnier flask, or if the sample is sufficiently fluid the Mojonnier weighing pipettes may be used. Seven cc. of distilled water are added (10 cc. of water when testing dry milk) and the solution well mixed. One and a half cc. of concentrated ammonia is then added and mixed with the weighed sample. To this is added 12 cc. of alcohol and the solution again mixed. Twenty-five cc. of isopropyl ether are now added and the flask shaken for 20 seconds after which it is allowed to stand for 15 minutes or centrifuged as in the standard method.

The separated ether layer is poured off into the weighed aluminum dish and a second extraction made as follows: Five cc. of alcohol are added and mixed with the solution, then 25 cc. of isopropyl ether and the flask shaken for 20 seconds, after which it is allowed to stand for 20 minutes or centrifuged.

The ether layer is raised to the mark if necessary by the addition of 50% alcohol and the ether poured into the aluminum dish containing the first extraction. The ether is evaporated off on a hot plate at a low heat using an asbestos pad.

The dish is then placed in the drying oven for 30 minutes at 100° C., cooled in the atmosphere and weighed.

TABLE I
Comparison of butterfat determinations between the Standard Mojonnier Method and Modified Method using isopropyl ether

SAMPLE NO.	PRODUCT	TEST NO.	STANDARD MOJONNIER METHOD		MODIFIED MOJONNIER METHOD	
			Per cent fat		*Per cent fat*	
1	Ice Cream	1	14.38		14.41	
	" "	2	14.39		14.42	
	" "	3	14.41		14.47	
			Average	14.39		14.43
2	" "	1	13.96		13.90	
	" "	2	13.94		13.99	
	" "	3	13.93		13.89	
	" "	4	13.92		13.95	
	" "	5	13.90		13.98	
	" "	6	13.94		13.90	
	" "	7			13.91	
	" "	8			13.97	
	" "	9			13.96	
	" "	10			13.98	
	" "	11			13.99	
			Average	13.93		13.95
1	Sour Cream	1	18.96**		18.95	
	" "	2	18.98**		18.93	
	" "	3			19.07	
	" "	4			18.98	
			Average	18.97		18.98
2	" "	1	19.04		19.05	
	" "	2	19.07		19.08	
	" "	3			19.08	
	" "	4			19.01	
			Average	19.06		19.06
1	Milk	1	3.94		4.01	
	"	2	3.99		3.95	
	"	3	3.95		4.00	
			Average	3.96		3.99
1	Buttermilk	1	0.51		0.52	
	"	2	0.54		0.53	
	"	3	0.54		0.53	
			Average	0.53		0.53
1	Evaporated Milk	1	7.61**		7.65	
	" "	2	7.64**		7.57	
	" "	3	7.66**		7.62	
	" "	4			7.62	
1	Milk Powder	1	4.32		4.30	
	" "	2	4.29		4.31	
	" "	3	4.30		4.33	
	" "	4	4.29		4.29	
			Average	4.30		4.31
2	" "	1	0.85**		0.85	
	" "	2	0.81**		0.85	
	" "	3	0.83**		0.87	
	" "	4			0.89	
	" "	5			0.87	
	" "	6			0.86	
			Average	0.83		0.87

** These results corrected for solids not fat observed to be present in the extracted fat. The average correction was − 0.20% as determined by actual weight.

In the Mojonnier standard method of analysis it is not unusual to observe a small percentage of solids not fat in the fat extract, which is corrected for by washing out the fat and weighing the solids. This is due to the solubility of the water alcohol solution in the ether. When isopropyl ether is used, the fat extract is in every case free from solids not fat.

TABLE I—(*Continued*)
Comparison of butterfat determinations between the standard Mojonnier method and modified method using isopropyl ether

SAMPLE NO.	PRODUCT	TEST NO.	STANDARD MOJONNIER METHOD		MODIFIED MOJONNIER METHOD	
			Per cent fat		*Per cent fat*	
3	Milk Powder	1	0.91		0.92	
	" "	2	0.85		0.97	
			Average	0.88		0.95
2	" "	1	0.85		0.88	
	" "	2	0.88		0.89	
			Average	0.87		0.89
5	" "	1	1.06		1.06	
	" "	2	1.11		1.11	
			Average	1.09		1.09

The usual Mojonnier procedure of evaporating the ether, drying and cooling may be followed if the Mojonnier apparatus is at hand.

DISCUSSION

Isopropyl ether offers no storage problem in hot weather and may be kept in the Mojonnier measuring apparatus without loss by evaporation such as experienced when using ethyl and petroleum ether. The low solubility of water in isopropyl ether is a distinct advantage in the determination of fat by the Mojonnier method. The use of a centrifuge is not required in order to assure complete separation of the isopropyl ether from the water alcohol solution of milk solids and the time required for an analysis is less in that the number of operations is reduced.

Technical isopropyl ether may be purchased practically free from non-volatile residue, making redistillation or blank determinations unnecessary. It is shipped in 1, 5, and 55 gallon non-returnable steel containers at an approximate cost of sixty cents per gallon and the deposit of four to eight dollars required on ethyl and petroleum ether containers is eliminated.

Isopropyl ether has a greater tendency to form peroxides than ethyl ether when kept in storage over long periods of time. Therefore there is more danger when making a dry distillation if the peroxides are not first destroyed. Storage over water or reducing agents inhibits the formation of peroxide.

The tendency of isopropyl ether to form an emulsion with water solutions requires the proper dilution of the solution with alcohol as shown in the procedure in order to get a clean cut separation.

SUMMARY

Results obtained in the extraction of fat from dairy products by this modified Mojonnier method are more accurate when using isopropyl ether than those with ethyl and petroleum ether, when no correction is made for milk solids carried over by the ethyl ether.

The use of isopropyl ether for fat extractions instead of ethyl and petroleum ether is time-saving, more convenient, and cheaper.

IMPROVED NOMOGRAPHIC CHARTS FOR DETERMINING THE RELATIVE VALUE OF FEEDS

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One of the most important problems confronting the livestock feeder is the purchasing of feeds economically. Whatever the circumstance, whether he is buying concentrates or roughages, to purchase the most feeding value per dollar is the object of the average man when buying feeds. Various criteria have been set up to aid the livestock feeder in purchasing feeds economically. It is generally recognized that the price of a feed is not a reliable indication of its value. Consequently, other methods based upon the nutrients contained in the feed which may actually be digested and utilized by the animal are much more reliable and worthwhile. It must be borne in mind that no system of measuring the nutritive value of feeding stuffs yet devised adequately considers the matter of quality of protein, minerals, vitamins, physical make-up or palatability. Such factors must be taken into consideration when feeds are purchased for feeding to livestock.

Perhaps the most widely used of these methods is that based upon the cost of one hundred pounds of total digestible nutrients. By use of this method it is possible to compare the value of one concentrate with another on the basis of the economy with which it supplies a unit of total digestible nutrients or carbohydrate equivalent. However, this method can be applied accurately, for feeds which are to be fed to animals for productive purposes, only when feeds are compared which have approximately the same fiber content. This is because of the fact that the energy cost of digestion is greater for feeds of a high fiber content. Consequently one hundred pounds of total digestible nutrients in a roughage is not equal in value for productive purposes to a similar amount of total digestible nutrients in a concentrate. This is also true in the case of concentrates widely different in fiber content.

In addition, as protein serves a special function in the body, this method is in error as it fails to consider the amount of protein contained in a feed. Therefore, a high-protein feed does not receive its proper ranking when it is to be used as a supplement to balance a ration low in protein, unless this feed is a cheap source of total digestible nutrients. Under usual price relationship high-protein feeds are higher in price than low-protein feeds, such as the cereal grains. Ordinarily, then the high-protein feeds would not be an especially cheap source of total digestible nutrients.

In order to properly evalute a feed, the fact that protein is especially important as a nutrient, and the fact that each unit of protein is actually

worth more than a unit of starch when high-protein feeds are higher in price than the low-protein feeds, must be taken into consideration. An attempt has been made to accomplish this by charging the entire cost of a high-protein feed to the protein and then determining the cost of a unit of protein. This method is obviously as much in error as the other, as it disregards the value of the remainder of the total digestible nutrients. A combination of the two methods, by which the value of a feed could be determined no matter what its composition and what price relationships exist between high-protein and low-protein feeds, would be ideal.

It is apparent that such a system to be accurate must then be based upon accurate net energy values and digestible protein, rather than upon total digestible nutrients and digestible protein. By the use of accurate net energy values it would then be possible to compare concentrates with roughages, and concentrates of low-fiber content with those higher in fiber. Unfortunately this is almost a practical impossibility, as few reliable data exist regarding the net energy values of our common feeding stuffs.

Consequently, a compromise has been necessary and a system of evaluating feeds based on their content of digestible protein and digestible nutrients has been developed. According to Petersen, Hayden of the Ohio Agricultural Experiment Station was the first to develop a method of evaluating a feed in which digestible protein was considered, as well as its content of total digestible nutrients. This method was designated as the cost per pound of "excess protein."

Petersen (2) devised a method using cottonseed meal as one base feed, representing an ordinarily cheap source of digestible protein, and corn, representing a cheap source of total digestible nutrients, as the other base. Petersen described his method in detail in 1932 and included a table showing constants for certain common feeds by which the price of the high-protein base feed and the price of the low-protein base feed must be multiplied and the result added, to obtain the value of the particular feed in question. A nomograph was presented on which, by aid of a straight edge, the value of a feed could be obtained with cottonseed meal and corn at any price. This obviated the need of computations. Stothart (3) adapted the Petersen method to Canadian conditions by calculating a series of constants for the common Canadian feeds based on linseed meal and barley as base feeds. He, also, prepared a nomographic chart which could be used to eliminate the calculations.

This method of evaluating feeding stuffs has found wide acceptance and is extremely useful. However, it is wholly accurate only when high-protein feeds are higher in price than low-protein feeds per unit of total digestible nutrients. When no premium is placed on protein, or when a pound of protein costs less than a pound of starch this method is inaccurate as it penalizes a feed for its protein content. When such a market condition

exists feeds should be compared only on the basis of the economy with which they supply total digestible nutrients.

With these facts in mind, the authors have developed the nomographic charts illustrated in this paper. These are based upon the Petersen method but are more comprehensive in that it is possibe to compare the value of feeds by three different methods all on the same chart. First, the relative value of feeds may be read from the chart according to the Peterson method. This method should be used only when high-protein feeds are higher in price than low-protein feeds. When there is no premium in price placed upon a unit of protein either of the remaining methods should be used. Second, the relative value of feeds based solely on their content of total digestible nutrients, or in some cases net energy, may be read from the chart. Third, for those who prefer to compare feeds on the basis of their relative cost per 100 pounds of total digestible nutrients, or cost per 100 therms of net energy, these values may be read from the chart with the feed at any particular price.

These charts are based upon the constants and factors for valuing feeding stuffs in Appendix Table VIII of Feeds and Feeding (1) which in turn are based upon the tables of composition and net energy values found in the same text. The constants and factors for all of the roughages and for a few concentrate feeds high in fiber are based upon the estimated net energy values of these feeds, the remainder are based upon the amount of total digestible nutrients which these feeds contain. For the original computations cottonseed meal containing 43 per cent protein was used as one base feed, while No. 2 corn was used as the other. This, however, does not affect the usefulness of the alignment charts as any economical source of protein may serve as one base feed and any cheap source of total digestible nutrients may be used as the other, when comparing feeds by the Petersen method.

It is fully recognized that such a chart does not consider many items of monetary value such as quality of protein, minerals, vitamins, physical make-up of the feed, or palatability, which unquestionably should be given careful consideration when purchasing feeds. It is also appreciated that the value of certain feeds for one class of stock may radically differ when fed to another class of stock. These charts have been developed as an aid to the feeder when purchasing feeds, but certainly cannot be used as a substitute for knowledge of the importance of the above factors.

DIRECTIONS FOR USING CHARTS

Charts 1 and 2 are based entirely upon the amounts of total digestible nutrients and digestible protein contained in each of the feeds. Most of the common concentrate feeds are to be found on these two charts. On the other hand, Charts 3 and 4 contain the common roughages fed to livestock and, as well, a few common concentrate feeds in order that a comparison

may be made of the relative value of the two types of feeds. These charts are based upon the estimated net energy values of these feeds and the amounts of digestible protein they contain.

The methds of determining the relative values of feeds are relatively simple and no equipment is required other than the charts and a straight edge. A ruler or black thread will be found to be very satisfactory.

Evaluating Feeds When Protein-rich Feeds Are Higher in Price Than Farm-Grown Grains

Place the chart so that the names of the feeds are at the left. The figures on each line representing a feed are the prices per ton of that feed. This line is calibrated in units of $1.00. Now select one feed as the low-protein base feed. This should be one of the farm-grown cereal grains or hominy feed, the one selected being the feed which seems cheapest. As the other base feed, the high-protein feed should be used which is apparently the cheapest source of protein.

When you have selected the base feeds, place a ruler or other straight edge with the edge toward the left, or a black thread will work nicely, on the price per ton of the low-protein base feed. Now, keeping the straight-edge on the particular price of the low-protein feed, place the edge of it on the line representing the high-protein base feed at its price per ton. The values of all other feeds may then be read off where the straight-edge crosses the line for each feed. For example; using Chart 1 and taking corn No. 2 at $30.00 and cottonseed meal at $40.00 a ton as the base feeds, rye is worth $31.00; wheat bran $29.00 plus; distillers' corn grains, dried, $38.00; brewers' grains, dried, $31.00; and corn gluten meal $43.00, per ton.

If the actual price of any one of these feeds is less than the value indicated, it is a good buy in terms of the base feeds. Naturally, the feeds which supply nutrients the most economically and from which the most satisfactory ration can be compounded should be purchased.

Under usual circumstances this method should be used in the selection of economical feeds. However, occasionally, as has been the case several times during the past two or three years in New York, certain high-protein feeds sell at a price which places no premium on the protein they contain. When this is the case the concentrates should be compared on the basis of the economy with which they furnish total digestible nutrients or net energy.

This price relationship between high-protein feeds and low-protein feeds may be readily determined from the chart. When the straight-edge is parallel to the base at the left as indicated by the guide lines at the top and bottom of the nomograph the basis of comparison is on total digestible nutrients or net energy alone. Under no circumstances should feeds be compared on these charts when the straight-edge is placed on the chart in

such a manner that the number of divisional markings on the top guide lines is less than the number on the bottom guide lines.

Evaluating Feeds When Protein-Rich Feeds Are as Cheap as the Grains

To compare feeds on the amount of total digestible nutrients or net energy which they contain, with no consideration given to the relative content of digestible protein, the straight-edge must be held in the same position as above, but must be parallel to the left side of the chart. This may be done by means of the guide lines which are placed at the top and bottom of chart. The straight-edge is parallel to the left side of the chart when it rests on the same divisional marking on the top and bottom guide lines.

Select any feed which appears to be economical as a base feed and move the ruler to the left until it rests at the price per ton of that feed. Be sure that the straight-edge is parallel to the left side of the chart. The relative value of the other feeds on the basis of total digestible nutrients or net energy and in relation to the base feed may then be determined by reading off the figures for each feed where the straight-edge crosses the line representing that feed. For example, using Chart 1, with corn at $30.00 a ton as the base feed, the straight-edge is parallel with the left of the chart when it rests at the 18¾ mark on the guide lines. In this example, wheat would be worth $31.00; wheat bran $26.00; soybeans $32.00; and cottonseed meal about $28.00 a ton.

When the actual price of a feed appears to the left of the straight-edge the feed is an economical one in relation to the base feed. If it appears to the right it is too expensive on the basis of the total digestible nutrients or net energy it contains and should not be purchased unless it has other virtues.

Calculating the Cost per 100 Pounds Total Digestible Nutrients or the Cost per 100 Therms Net Energy

Owing to the prevalence of the practice some who use the chart may wish to calculate the cost of 100 pounds of total digestible nutrients, or the cost of 100 therms of net energy. This may be done very easily, if the straight-edge is parallel to the left of the chart, by placing the left edge of the straight-edge on the price of any feed for which it is desired to know the cost per 100 pounds total digestible nutrients or 100 therms net energy, and then reading off the cost on the line which is labelled "cost per 100 pounds total digestible nutrients" on Charts 1 and 2, or "cost per 100 therms net energy" on Charts 3 and 4. This line is calibrated in units representing $0.10, while by estimation it seems possible to read the cost to the nearest $0.05. On Chart 1 when corn costs $30.00 a ton it furnishes 100 pounds of total digestible nutrients for about $1.85.

If one wishes to compare the value of a feed on one chart with that of a feed on another, it is possible to do so by noting the calibration on the cottonseed meal line (43% protein) and on the corn line where the straight-edge crosses them and then placing the straight-edge on the same marks on the cottonseed meal and corn lines on the other chart. In transferring from a chart based on total digestible nutrients to another calculated on the same basis, the comparison is, of course, identical. However, there will be some variation in changing from a chart based on total digestible nutrients to one based on net energy. This is true of oats, barley, and distillers' corn grains, dried, as they are found on both Charts 1 and 3 and in one case the basis of comparison is total digestible nutrients and the other is net energy.

These charts, in a size from which the information may be more easily read may be obtained from the authors.

SUMMARY

Four nomographic charts are presented from which the relative value of feeds may be determined for the common feeds by three different methods.

1. The Petersen method. To be used only when high-protein feeds are higher in price than low-protein feeds.

2. The method of comparing feeds on the basis of their relative content of total digestible nutrients or net energy. To be used when protein-rich feeds are as cheap as the grains.

3. The cost per 100 pounds of total digestible nutrients or 100 therms of net energy. To be used as under method 2 above.

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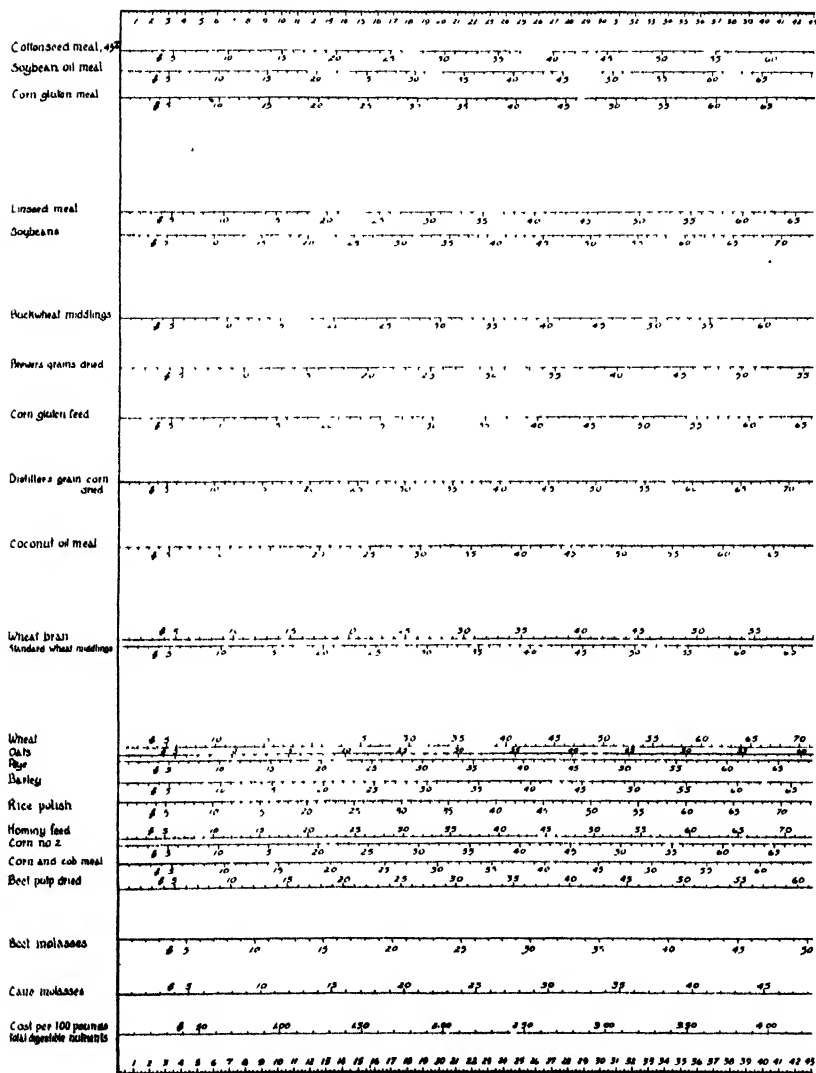
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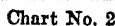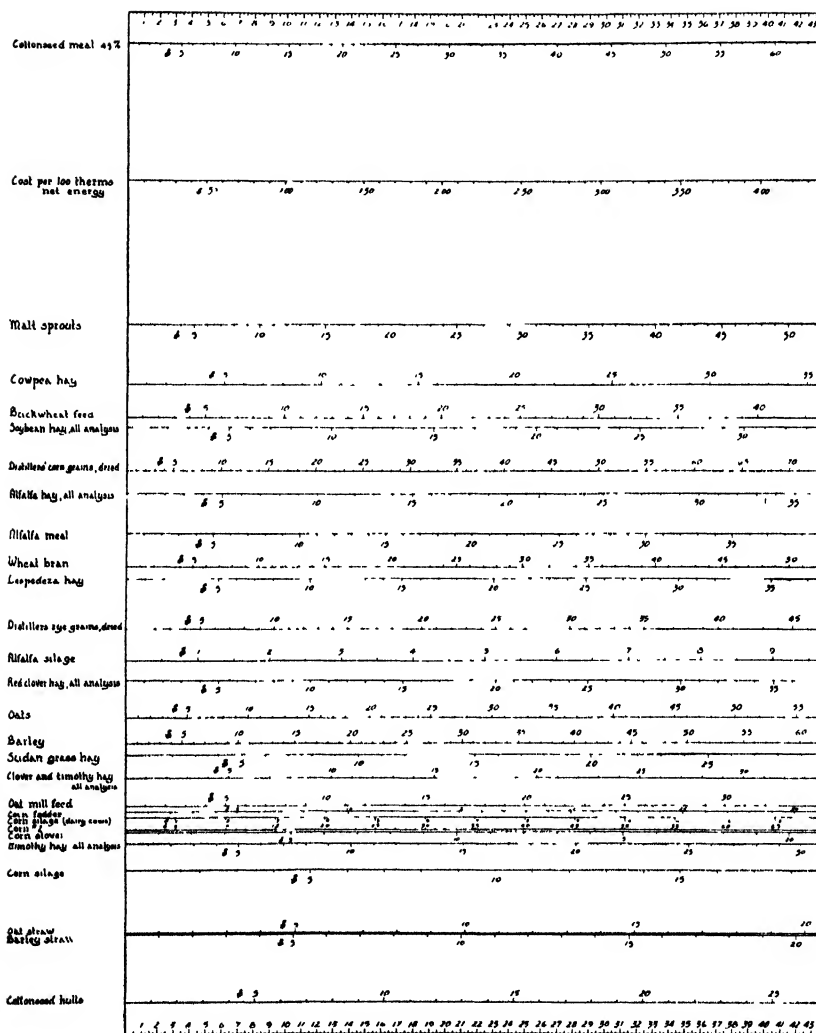
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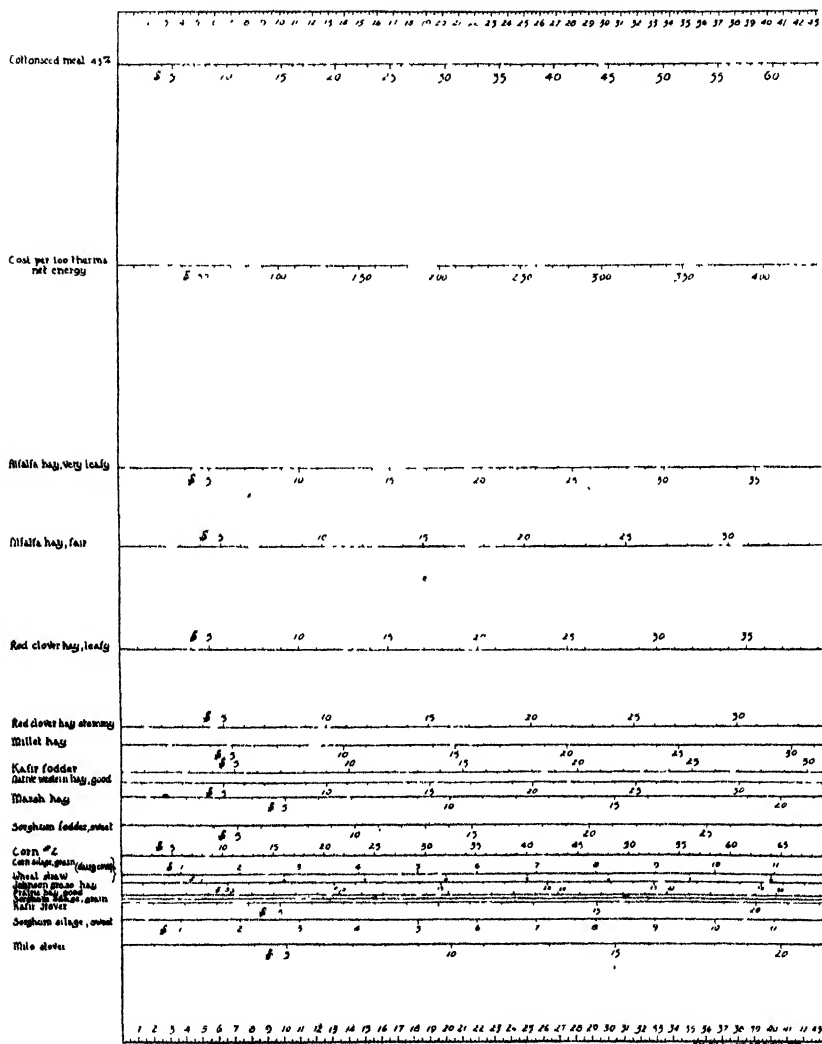
Chart No. 3

Chart No. 4

FURTHER STUDIES ON SKIMMILK AGAR FOR ROUTINE MILK COUNTS

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Previous studies on modifications of the standard agar plating medium approved by the American Public Health Association revealed that a combination containing 2.0 per cent fluid skimmilk, 0.5 per cent Bacto peptone, 0.1 per cent each of Bacto beef extract and glucose and 1.5 per cent agar, gave counts on 618 pasteurized milk samples which were from two to four times as large as corresponding counts using the approved standard agar (1). On 137 samples of raw milk, the counts with the modified medium were only slightly greater than those on the standard agar. The presence of skimmilk increases the size of the colonies and permits differentiation of acid-producing and caseolytic types. Excessive amounts of skimmilk may be precipitated in the medium while less than 2 per cent will not allow definite differentiation of colony types (2).

Tryptone, a trypsin hydrolyzed casein, is superior to peptone as a source of nitrogen (3, 4). Bowers and Hucker in their media comparisons have shown that an agar containing 0.5 per cent tryptone, 0.1 per cent glucose, and 1.5 per cent agar, gave the highest counts. They also found that bacterial counts on this agar might be increased slightly by the addition of 0.5 per cent skimmilk.

NEW DATA

The data herein summarized were secured from a comparison of bacterial counts on milk samples using (1) standard agar, (2) Bowers and Hucker basic medium plus 0.5 per cent skimmilk and (3) Bowers and Hucker basic medium plus 2.0 per cent skimmilk. The samples represent essentially 215 widely distributed New York State milk supplies.

Based on the average percentage differences, the counts on pasteurized milk with the tryptone-glucose-skimmilk agars were about three times as large as the corresponding standard agar counts. The counts on the medium containing the 2.0 per cent skimmilk were larger than those on the medium containing 0.5 per cent skimmilk. With raw milk samples each of the skimmilk agars gave slightly higher counts than the standard medium. The results on only 209 of the 215 samples are compared in Table 1.

The distribution of percentage differences in counts on pasteurized milk with each of the two skimmilk agars as compared with the standard agar count is shown in Table II. Nearly all of the counts on the two skimmilk agars were higher than the standard agar count, only a few being definitely less than the standard count.

TABLE I

*Average percentage increase of counts on tryptone-glucose-skimmilk agars over
standard agar count*

SAMPLES	NO. TESTED	SKIMMILK CONTENT OF AGAR	
		0.5 PER CENT	2.0 PER CENT
Pasteurized milk	190	180 per cent	215 per cent
Raw milk	19	17 per cent	16 per cent

TABLE II

*Frequency of percentage differences between counts on tryptone-glucose-skimmilk agars
and standard agar count—pasteurized milk samples*

PERCENTAGE DIFFERENCE RANGE	NUMBER OF SAMPLES	
	0 5% SKIMMILK	2.0% SKIMMILK
Negative values greater than 25 per cent	3	5
−1 to −25 per cent	17	12
0 to 25 per cent	40	28
26 to 100 per cent	74	79
101 to 200 per cent	26	31
201 to 500 per cent	17	19
501 to 2000 per cent	11	14
Over 2000 per cent	2	2
Total	190	190

Since a more direct comparison of the two skimmilk media was desired,
the percentage differences between the counts obtained on pasteurized milk
with these media were determined. The distribution of these differences
given in Table III shows that the 2 per cent skimmilk agar gave higher
counts on 117 samples (positive percentage difference), lower counts on 67
samples and the same count on 12 samples. From the standpoint of maxi-
mum counts, the 2 per cent skimmilk agar is preferred.

TABLE III

*Frequency of percentage differences between counts on 2 per cent skimmilk agar and 0.5
per cent skimmilk agar—pasteurized milk samples*

PERCENTAGE DIFFERENCE RANGE	NUMBER OF SAMPLES
Negative values greater than 50 per cent	5
−26 to −50 per cent	6
−11 to −25 per cent	22
−1 to −10 per cent	34
0 to 10 per cent	51
11 to 25 per cent	42
26 to 50 per cent	23
51 to 75 per cent	9
Over 75 per cent	4
Total	196

A graphic illustration of these results is shown in Figures I, II, and III. In Figures I and II, the logarithms of the standard agar counts are charted on the diagonal line, while the logarithms of the corresponding skimmilk agar counts appear at terminals or on the vertical lines above or below the point where the standard agar count is plotted. Figure I compares the magnitude of the standard agar counts and the tryptone-glucose-0.5 per cent skimmilk agar counts. The comparison is identical in Figure II except that 2.0 skimmilk replaces the 0.5 per cent skimmilk. Since practically all of the
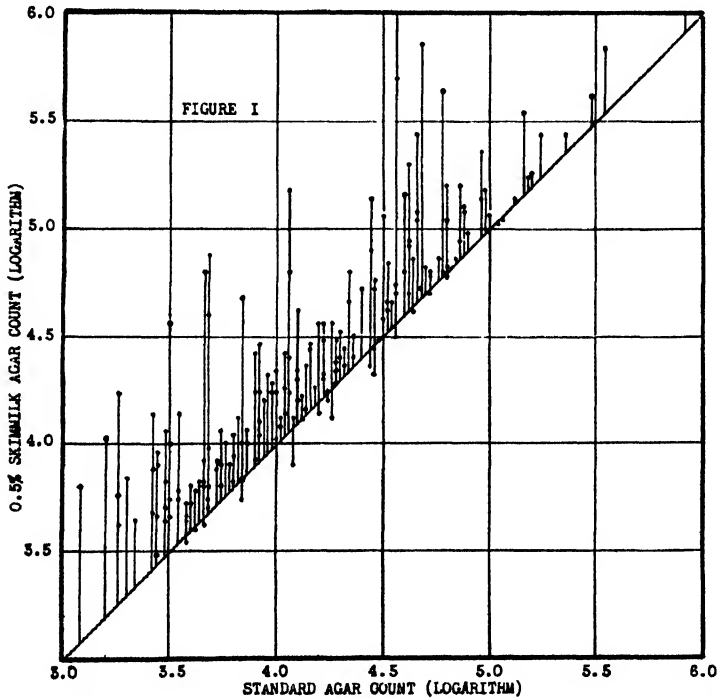
Fig. 1. Relation between counts on 190 pasteurized milk samples using standard agar and tryptone glucose agar containing 0.5 per cent skimmilk. Standard agar counts plotted on diagonal line.

vertical lines of appreciable length are above the diagonal, it is obvious that nearly all of the skimmilk agar counts are greater than the standard agar counts.

Figure III is a similar comparison but limited to the two skimmilk agars, the 0.5 per cent skimmilk agar counts being plotted on the diagonal. While the logarithmic differences are not great, they do distinctly show a trend in favor of the medium containing the 2.0 per cent skimmilk.

The logarithmic averages of the standard agar plate counts, the 0.5 per

cent skimmilk agar counts, and the 2.0 per cent skimmilk agar counts are respectively 15,100, 27,700 and 29,200.   On this basis, the 0.5 per cent skimmilk agar counts averaged 83 per cent greater than the standard agar counts.   The 2.0 per cent skimmilk agar counts averaged 93 per cent more than the standard agar counts and 5.4 per cent more than the 0.5 per cent skimmilk agar counts; thereby confirming previous statements in this report.
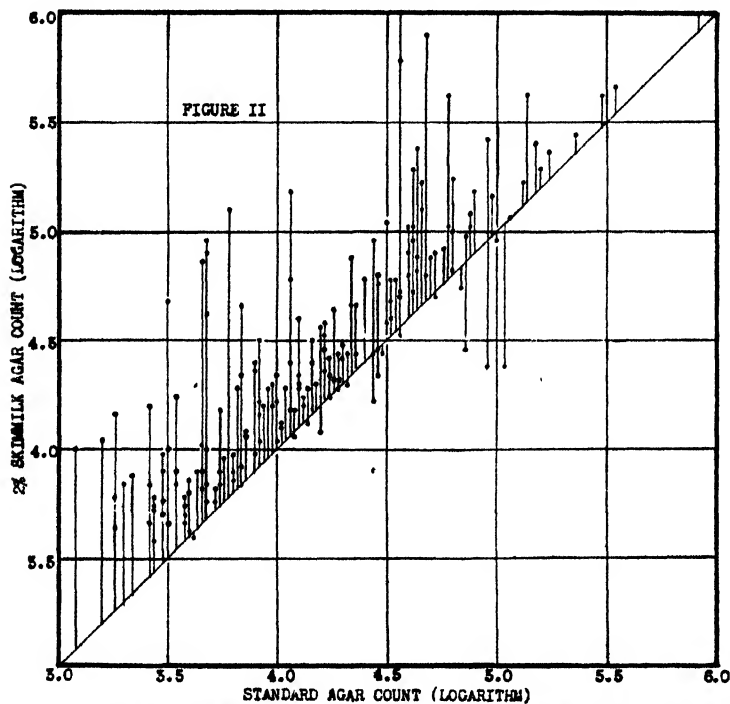
FIG. II.   Relation between counts on 190 pasteurized milk samples using standard agar and tryptone glucose agar containing 2 per cent skimmilk.   Standard agar counts plotted on diagonal line.

SUMMARY AND CONCLUSIONS

Tryptone-glucose-skimmilk agar media containing (a) 0.5 per cent skimmilk and (b) 2.0 per cent skimmilk, gave counts on 190 samples of pasteurized milk which averaged significantly higher than those obtained on standard agar.   Using arithmetical averages of percentage differences, the 0.5 per cent skimmilk agar counts were 180 per cent higher and the 2.0 per cent skimmilk agar counts 215 per cent higher than the corresponding standard agar counts.

The 2.0 per cent skimmilk agar possesses differential value for bacterial

types which obviously can be disregarded when only the total count is desired. The advantages gained in using one medium which has differential value would also be noted in the bacteriological examination of various types of dairy products, such as butter, cheese and starters.
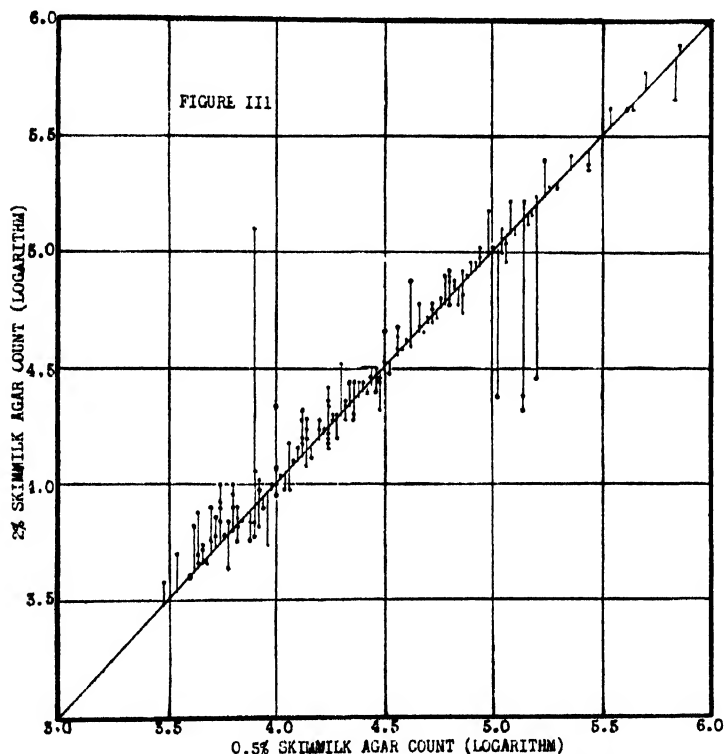
FIG. III. Relation between counts on 190 pasteurized milk samples using tryptone glucose agar containing 0.5 per cent skimmilk and 2 per cent skimmilk. The 0.5 per cent skimmilk agar counts are plotted on the diagonal line.

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WORKING MAINTENANCE AS A FUNCTION OF LIVE WEIGHT IN DAIRY COWS, AND ITS BEARING ON AN ENERGY–SIZE INDEX OF LACTATION

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The term "working maintenance" is here used to refer to that portion of the total nutritional (digestible nutrient or digestible feed energy) cost of milk production, which as between dairy cows of different live weights is properly chargeable to maintenance under practical working conditions in the milking herd. Working maintenance is a major item in the feed cost of milk production. Its proper expression as a function of live weight is of intense practical interest. Using symbols,[1] Haecker (1) expresses it as $DN'' = .007925W$. Brody and Procter (2) express it as $DN'' = .053W^{.73}$. Haecker derived his formula from determinations of the digestible nutrients required to maintain dry farrow cows, and from skilled observation as to how the values so obtained fitted into practice in the milking herd at the Minnesota Station. Brody and Procter derived their formula: first, by determination of basal metabolism as between species varying in live weight from ½ ounce (mouse) to 4 tons (elephant) and found it could be beautifully expressed as $Q = 39.5W^{.734}$, where Q is basal metabolism in calories per day; second, by assuming that working maintenance is simply a multiple of basal metabolism or directly proportional to $W^{.73}$; third, by statistical treatment of the published experimental data of feed, live weight and milk yield of the milking cows of Haecker and other Experiment Station sources. Their treatment of the data gives no information as to the validity of the exponent .73 in the equation $DN'' = .053W^{.73}$ but merely derives the coefficient .053 if .73 is the proper exponent.

The present paper attempts to compare the validity of Brody and Procter's working maintenance exponent .73 with Haecker's working maintenance exponent 1.00, by obtaining a first approximation to the exponent

[1] Symbols are used, to apply to each experimental period for each cow as follows:

DN = digestible nutrients intake, pounds per day.
DN' = digestible nutrients apportioned to lactation, pounds.
DN'' = digestible nutrients apportioned to maintenance, pounds per day.
DN''' = digestible nutrients apportioned to gain in weight, pounds.
$y = DN$ minus DN''^{1}
FCM = milk energy yield, pounds of 4 per cent milk per day. (= pounds milk per day × .4 + pounds fat per day × 15. Milk energy of one pound 4 per cent milk = 340 calories.)
W = average light weight, pounds.
$\triangle W$ = gain in live weight, pounds per day.
IW = live weight 3 days after calving, pounds. (Applied to FCM for the following 8 months, 243 days, as experimental period.)
D = observed y minus calculated y.
n = number of records.

actually indicated by the experimental data themselves. A special point of interest lies in the bearing of the working maintenance exponent on an energy-size index of lactation (2, 3, 4, 5, 6, 7, 8).

<div align="center">DATA AND METHODS</div>

The data used here are taken from the convenient compilation published by Brody and Cunningham (9). The data are treated in various groups as indicated in Table 1. All the records are for mature cows, younger cows having been excluded to avoid complications of growth. Except for the 10 records of Forbes, the records used are the same ones used by Brody and Procter in deriving their equation $DN'' = .053W^{.73}$.

Following the general style of Brody and Procter, it is assumed that DN may be partitioned between FCM, W and $\triangle$W by the least-squares fitting of an appropriate equation to the experimental observations. It is desired to express working maintenance as a function of live weight in the form $DN'' = bW^c$, in which we are specially concerned with the evaluation of c or working maintenance exponent. A direct determination of c is not possible but an indirect first approximation by trial and error is attempted as follows.

It is assumed with Knott, Hodgson and Ellington (10) that a pound of gain in live weight corresponds to 3.53 pounds of digestible nutrients, and a pound of loss in live weight corresponds to 2.73 pounds of digestible nutrients. Accordingly, $y = DN - 3.53\triangle W$ for the $+\triangle W$'s, and $y = DN - 2.73\triangle W$ for the $-\triangle W$'s. That is, $y < DN$ for the $+\triangle W$'s, and $y > DN$ for the $-\triangle W$'s.

We now proceed to partition y between FCM and W by assuming that $DN' = aFCM$ and $DN'' = bW^c$ and hence $y = aFCM + bW^c$. This equation is fitted to the observed y's, FCM's, and W's by least squares, using trial values for c of 0, .15, .30, .45, .60, .73, .87, 1.00, 1.13, 1.27, 1.40, 1.70 and 2.00. From the corresponding equations, for each of the groups of records indicated in Table 1, ΣD^2 for each trial value of c is calculated as $\Sigma D^2 = \Sigma y^2 - a\Sigma FCMy - b\Sigma W^c y$. For any particular group of records the trial value of c giving the lowest value of ΣD^2 is taken to be the working maintenance exponent indicated for the particular group of records, since the corresponding equation reduces the sum of the squares of the differences between the observed and calculated values of y to a minimum and is therefore the least-squares fit, within limitations of the procedure. The equation constants, with related data, are given in Table 2.[2] Since b of itself is difficult of comprehension when c differs from 1 or 0 it is reported in Table 2 as

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[2] To secure accuracy in ΣD^2 it is necessary to use more figures for a and b than given in the table. In the present work 8 significant figures have been used for a and b, as solved from the normal equations: $\Sigma(FCM)^2a + \Sigma(FCM)W^c b = \Sigma(FCM)y$ and $\Sigma(FCM)W^c a + \Sigma(W^c)^2 b = \Sigma W^c y$.

TABLE 1

Number of records, by original source, breed of cow, and sign of $\triangle W$

SOURCE OF DATA	GUERNSEY			HOLSTEIN			JERSEY			ALL BREEDS		
	$+\triangle W$	$-\triangle W$	$\pm\triangle W$	$+\triangle W$	$-\triangle W$	$\pm\triangle W$	$+\triangle W$	$-\triangle W$	$\pm\triangle W$	$+\triangle W$	$-\triangle W$	$\pm\triangle W$
Haecker	8*	8*	16*	16*	11*	27*	19*	36*	55*	43*	55*	98*
Forbes	0	0	0	7*	3	10*	0	0	0	7**	3	10**
Harrison				80*	23*	103*	0	0	0	80**	23**	103**
Savage	2	0	2	14*	0	14**	6	0	6	22*	0	22**
Hill	0	0	0	4	0	4	5	0	5	9*	0	9**
Eckles	0	0	0	2	0	2	5	0	5	7*	0	7**
Perkins	0	0	0	4	0	4	0	0	0	4	0	4
All Sources	10*	8**	18*	127*	37*	164*	35*	36*	71*	172*	81*	253*

* The records of each starred group are used to determine a first approximation of the working maintenance exponent. The double star indicates the group is a duplicate of a preceding group, reading normally.

b1000^c. The expression b1000^c represents the pounds of digestible nutrients per day apportioned to working maintenance of a 1000-pound cow.

While ΣD^2 serves for any one group to indicate the least-squares fit with respect to c it is not comparable between groups where n is variable. On this account $\Sigma D^2/(n-2)$ is used, to allow for the number of records in the group, and for the two constants, a and b, in the equation as fitted. The values of $\Sigma D^2/(n-2)$ for the trial values of c are given in Table 3 and plotted in Figure 1.

TABLE 2

First approximation of the working maintenance exponent, c, in the Equation $y = aFCM + bW^c$ for the starred groups of Table 1; and related data

ORIGINAL SOURCE	BREED* OF COWS	SIGN OF $\triangle$W	n	MEAN OF W	RANGE** IN W	$\dfrac{\Sigma D^2}{n-2}$	a	b1000^c	c
Haecker	G	+	8	852	254	.711	.326	8.56	1.27
do	G	–	8	897	197	.531	.265	11.25	2.30
do	G	+ & –	16	874	254	.751	.287	9.70	1.40
do	H	+	16	1049	534	2.445	.053	15.05	.60
do	H	–	11	962	429	.668	.341	7.38	.73
do	H	+ & –	27	1013	534	2.070	.185	11.93	.45
do	J	+	19	858	336	.436	.255	8.85	.30
do	J	–	36	820	379	1.168	.259	9.91	1.00
do	J	+ & –	55	833	437	.959	.258	9.20	.60
do	GHJ	+	43	928	580	1.511	.208	10.73	.60
do	GHJ	–	55	860	639	1.070	.296	8.81	1.00
do	GHJ	+ & –	98	890	681	1.321	.259	9.54	.73
Forbes	H	+	7	1134	441	.030	.254	8.70	.60
do	H	+ & –	10	1131	541	.599	.368	4.81	1.27
Harrison	H	+	80	1278	372	.818	.297	9.00	.15
do	H	–	23	1285	346	.440	.268	11.17	.15
do	H	+ & –	103	1280	419	1.039	.308	8.96	.15
Savage	H	+	14	1129	356	1.274	.213	12.34	.45
do	GHJ	+	22	1046	529	1.307	.266	9.98	.73
Hill	HJ	+	9	1094	505	1.482	.413	5.86	.87
Eckles	HJ	+	7	966	512	.308	.428	4.99	.30
All Sources	G	+	10	873	307	.896	.247	9.89	.73
do	G	–	8	897	197	.531	.265	11.25	2.30
do	G	+ & –	18	884	307	.987	.274	9.51	1.00
do	H	+	127	1226	672	1.496	.292	8.93	.30
do	H	–	37	1176	656	.692	.269	9.85	.60
do	H	+ & –	164	1215	719	1.455	.301	8.57	.45
do	J	+	35	874	336	.678	.311	7.74	.45
do	J	–	36	820	379	1.168	.259	9.91	1.00
do	J	+ & –	71	847	437	.977	.291	8.30	.60
do	GHJ	+	172	1134	718	1.312	.303	8.27	.45
do	GHJ	–	81	990	866	.995	.293	8.66	.87
do	GHJ	+ & –	253	1088	866	1.311	.305	8.15	.60

* G = Guernsey; H = Holstein; J = Jersey.

** W for heaviest cow minus W for lightest cow.

TABLE 3

Values of $\Sigma D^2/(n-2)$ for the various trial values of c in the equation $y = aFCM + bW^c$ fitted by least squares to the records of the starred groups of Table 1. The black face figures indicate, for the particular group the best of the trial values of c, that is, the lowest $\Sigma D^2, (n-2)$

ORIGINAL SOURCE	BREED OF COWS	SIGN OF ΔW	0	.15	.30	.45	.60	.73	.87	1.00	1.13	1.27	1.40	1.70	2.00
									TRIAL VALUE OF c					
Harrison	H	+	.83	**.82**	**.82**	.84	.87	.91	.97	1.02	1.08	1.16	1.23	1.39	1.63
Harrison	H	−	.44	**.44**	.47	.55	.66	.78	.94	1.10	1.28	1.48	1.67	2.10	2.50
Harrison	H	+ & −	1.05	**1.04**	**1.04**	1.06	1.10	1.15	1.21	1.28	1.35	1.44	1.52	1.71	1.95
Eckles	HJ	+	.39	.34	**.31**	.32	.37	.46	.59	.75	.92	1.12	1.31	1.70	2.00
Haecker	J	+	.52	.46	**.44**	.45	.50	.61	.65	.75	.85	.97	1.08	1.33	1.56
All Sources	H	+	1.65	1.54	**1.50**	**1.50**	1.55	1.62	1.72	1.81	1.93	2.06	2.19	2.44	2.71
Savage	J	+	1.59	1.42	1.31	**1.27**	1.31	1.38	1.49	1.61	1.74	1.88	2.00	2.28	2.51
All Sources	J	+	.74	.70	**.68**	**.68**	.69	.74	.76	.81	.86	.92	.98	1.14	1.30
All Sources	GHJ	+	1.88	1.61	1.41	**1.31**	1.32	1.41	1.56	1.73	1.93	2.15	2.37	2.77	3.12
Haecker	H	+ & −	3.30	2.49	2.32	**2.07**	2.09	2.23	2.45	2.69	2.94	3.21	3.45	3.94	4.34
All Sources	H	+ & −	1.76	1.59	1.49	**1.46**	1.48	1.54	1.63	1.73	1.84	1.97	2.10	2.35	2.61
Forbes	H	+	.33	.19	.09	.04	**.03**	.05	.08	.12	.17	.21	.25	.34	.40
Haecker	H	+	4.26	3.54	2.94	2.55	**2.45**	2.61	2.99	3.48	4.04	4.64	5.18	6.26	7.06
Haecker	GHJ	+	2.55	2.18	1.86	1.62	**1.51**	1.57	1.66	1.86	2.10	2.39	2.66	3.22	3.67
All Sources	H	−	1.97	1.45	1.04	.79	**.69**	.71	.81	.93	1.08	1.24	1.39	1.71	2.00
Haecker	J	+ & −	1.25	1.13	1.05	.98	**.96**	.98	.98	1.01	1.05	1.10	1.16	1.29	1.42
All Sources	J	+ & −	1.22	1.12	1.05	1.00	**.98**	**.98**	**.98**	1.01	1.02	1.06	1.10	1.20	1.32
All Sources	GHJ	+	2.32	1.94	1.61	1.40	**1.31**	**1.31**	1.45	1.60	1.77	1.97	2.15	2.50	2.79
Savage	GHJ	+	2.20	1.95	1.69	1.48	1.33	**1.31**	1.34	1.44	1.56	1.72	1.86	2.18	2.42
All Sources	G	+	1.52	1.35	1.18	1.04	.94	**.90**	.92	.99	1.11	1.27	1.44	1.82	2.10
Haecker	H	+ & −	1.20	1.01	.85	.74	.68	**.67**	.68	.69	.72	.75	.78	.84	.92
Haecker	GHJ	+ & −	2.20	1.92	1.67	1.48	1.35	**1.32**	1.33	1.40	1.51	1.65	1.79	2.11	2.39
Hill	HJ	+	2.83	2.40	2.04	1.78	1.61	1.52	**1.48**	**1.48**	1.52	1.57	1.64	1.81	2.00
All Sources	GHJ	−	2.94	2.56	2.07	1.57	1.19	1.02	**.99**	1.07	1.19	1.35	1.49	1.78	2.01
Haecker	J	−	1.66	1.53	1.40	1.31	1.23	1.19	**1.17**	**1.17**	1.18	1.20	1.23	1.30	1.39
Haecker	GHJ	−	1.80	1.65	1.49	1.34	1.22	1.14	1.09	**1.07**	1.08	1.11	1.16	1.30	1.45
All Sources	G	+ & −	1.71	1.56	1.41	1.27	1.15	1.07	1.01	**.99**	**.99**	1.03	1.09	1.30	1.53
Haecker	G	+	1.94	1.71	1.48	1.26	1.06	.92	.81	.75	**.71**	**.71**	.72	.81	.93
Forbes	H	+ & −	1.28	1.25	1.17	1.05	.90	.78	.69	.64	.61	**.60**	**.60**	.62	.65
Haecker	G	+ & −	1.93	1.75	1.49	1.38	1.22	1.09	.97	.88	.81	.77	**.75**	.79	.90
Haecker	G	−	2.55	2.36	2.17	1.96	1.78	1.61	1.44	1.29	1.15	1.02	.90	.70	**.58***

* The value of $\Sigma D^2/(n-2)$ decreases to .53 at $c = 2.30$, then increases to .56 at $c = 2.60$.
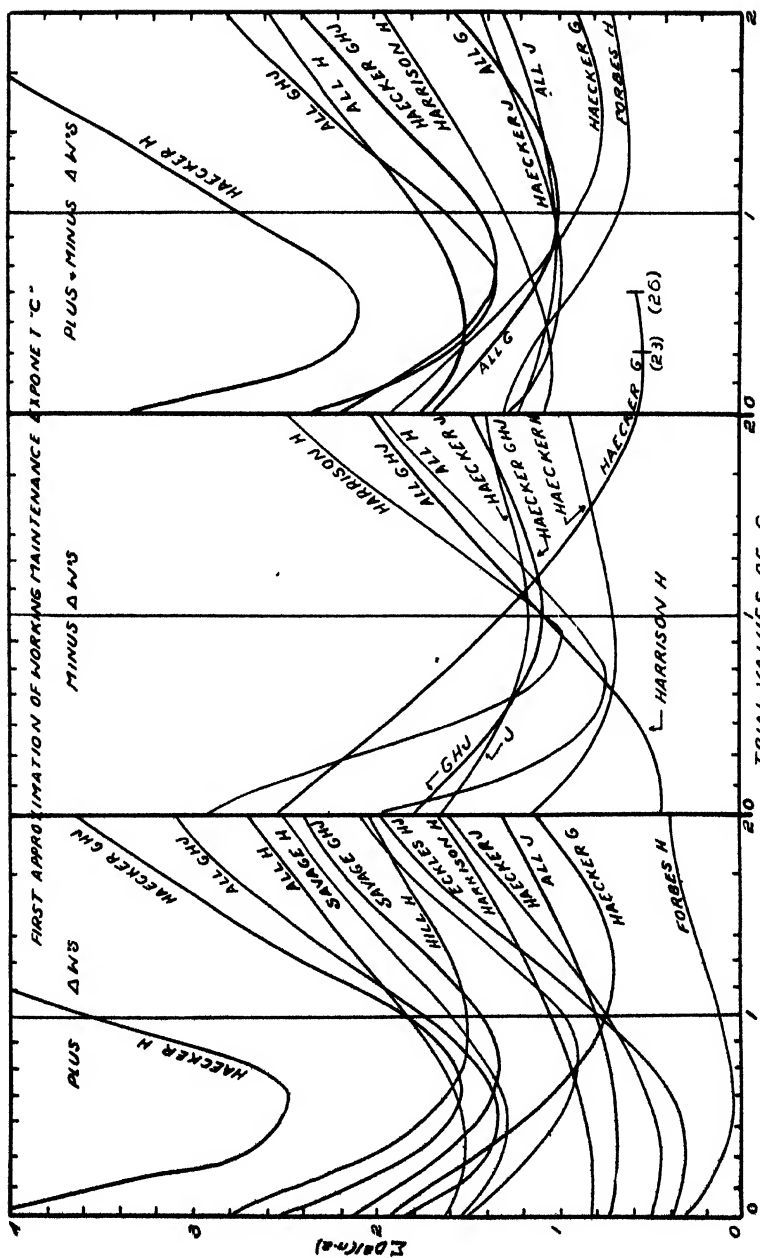
Fig. 1. Change in $\Sigma D^2/(n-2)$ with change in c for the starred groups of Table 1. The letters, G, H, J, indicate the breeds: G for Guernsey, H for Holstein, J for Jersey. The low point of any curve indicates for that particular group of records the best first approximation of the working maintenance exponent, c.

The first step in the present estimate of the working maintenance exponent introduces the uncertainty of the allowance made for $\triangle W$. Brody and Procter treated $\triangle W$ as acting equally whether the cow gained in live weight $(+ \triangle W)$ or lost in live weight $(- \triangle W)$ during the experimental period, and found $DN''' = 2.1 \triangle W$. The present allowance is somewhat greater than this but is used in preference to $2.1 \triangle W$ on the theory that for purposes of estimating DN' or DN'' the nutrients used for a pound of gain in live weight cannot be recovered 100 per cent in a pound of loss in live weight. In any case, DN''' is minor in magnitude as compared to DN' or DN''. Nevertheless, the expression of DN' as a function of FCM, and of DN'' as a function of W may be profoundly influenced by the physiological state represented by a cow gaining in weight as compared with that represented by a cow losing in weight during the experimental period of lactation. The present disposition of DN''' is justified only to simplify the problem and make it workable as a first approximation in evaluating the constants for lactation and working maintenance.

Considering the 253 records in lump, Table 2 (last line) shows $DN' = .305FCM$, which agrees exactly with Brody and Procter's results; and $DN'' = .129W^{.60}$, in comparison with their $DN'' = .053W^{.73}$, which two equations give the same result for DN'' when $W = 937$, and do not differ by more than 8 per cent at other values of W from 600 to 1800. Furthermore, as may be seen from Table 3 or Figure 1 (curve marked "All GHJ," right-hand section) there is little choice between $c = .60$ and $c = .73$; while $c = .73$ is distinctly indicated in preference to $c = 1.00$. The lumped data, therefore, support the validity of Brody and Procter's working maintenance exponent .73 in preference to Haecker's exponent 1.00, or Morrison's (11) exponent .87.

When we examine the similar data for the various subgroups, great confusion develops. There are differences according to original source of the experimental data, according to breed of cow, according to sign of $\triangle W$. As to source, an item that may be important is the portion of lactation represented. Thus, Haecker's data are for periods varying in length from 7 weeks to 26 weeks, and somewhat variable as to stage of lactation. Harrison's data, on the other hand, are for either the 3d–37th weeks or 3d–40th weeks of lactation. As to breed, there are 18 Guernsey records, 164 Holstein records and 71 Jersey records. For all records lumped together, Holstein dominates by reason of numbers.[3] Throwing the breeds together should have an advantage, however, in providing greater range of live weight. As to sign of $\triangle W$, a possible difference in physiological state of the cow has

[3] The 164 Holstein records are in turn dominated by the 103 records of Harrison, which give the very peculiar result that working maintenance is proportional to $W^{.15}$, or substantially independent of live weight.

been noted. It should be noted further that $a - \triangle W$ does not mean that the cow was losing weight throughout the experiment; neither does $a + \triangle W$ mean that she may not have lost weight in the early stages of lactation. It might be better to apply the analysis to short periods of lactation, comparable as to stage of lactation and direction of change in live weight.

Considering the $172 + \triangle W$ records as a group, we find the best value of c to be .45. The various $+ \triangle W$ subgroups as given in Figure 1 (left-hand section) show considerable variation, but may be taken to indicate that working maintenance is proportional to the square root of live weight. It is difficult to accept this result as correctly representing working maintenance if we accept basal metabolism as proportional to $W^{.73}$. Working maintenance involves, for example, locomotion and the energy required for locomotion probably varies directly with W (rather than $W^{.73}$).[4] If basal metabolism is proportional to $W^{.73}$ we should expect working maintenance to be proportional to live weight to some power greater than .73. In these $172 + \triangle W$ records it is possible that lactation is forced by the pressure of a surplus of nutrients, and that under such conditions the assumption that $DN' = aFCM$ may involve a serious error.

Considering the $81 - \triangle W$ records as a group, we find the best value of c to be .87. The various $- \triangle W$ subgroups as given in Figure 1 (center section) show a great range in the best value of c — from Harrison's Holsteins ($c = .15$, with $c = 0$ equally acceptable) to Haecker's Guernseys ($c = 2.30$). Is this difference a matter of breed, stage of lactation represented, accident of sampling, or what? It may be noted that Haecker's $- \triangle W$ records for all breeds together support his working maintenance exponent 1.00. In fact, this is a fair compromise value for all the $- \triangle W$ subgroups of Figure 1.

The feeding standards illustrated in Figure 2 show considerable disagreement, one with another. Evidently the estimate of working maintenance from a practical feeding standpoint is not very exact or well established. It appears from the present analysis that it cannot be very consistently expressed as proportional to live weight to some fixed power. Perhaps some factor not closely associated with live weight plays a prominent part. Insofar as working maintenance can be expressed as a function of live weight there appears to be no need to depart from Haecker's simple expression,[5] $DN'' = .008W$.

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[4] Distance of travel also enters into the energy of locomotion. Distance of travel may depend on individual disposition or, in the case of grazing animals, it may be related to W. The larger the cow the more herbage she will eat and the greater the distance she must travel in grazing, and since W thus enters twice into the equation it would tend to make the energy of locomotion vary as W^2.

[5] In view of the variability in the determined values of working maintenance it is permissible to round Haecker's .007925 into .008. Also, his coefficient, .327, for FCM may apparently be reduced to .3. The equation of his feeding standard then becomes $DN = .3FCM + .008W$.

BEARING ON AN ENERGY-SIZE INDEX

It would seem almost obvious that a record of size of cow should accompany the record of milk yield. Nevertheless, size records, in the form of live weight or linear dimensions of body, have been tried and abandoned by several breed associations in the course of development of their milk recording systems. This may be taken to mean that the importance of size of cow is evident by common observation, but as thus far used the size measurements have not served a very useful purpose. There is need to introduce size into the record in some practical and meaningful way.

Live weight has usually been estimated by eye, leading to inaccuracies. This situation could be improved by use of a chest girth measurement (in
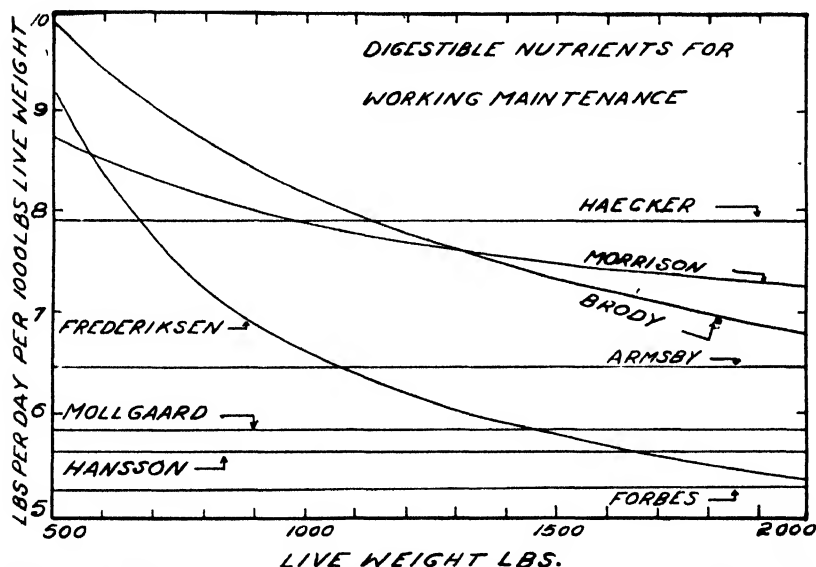
FIG. 2. Digestible nutrients required for working maintenance of dairy cows of various live weights, according to 8 different feeding standards.

the absence of scales) in estimating the live weight. Also, the live weights have been estimated at variable stages of lactation and gestation, which further impairs their usefulness in the problem of evaluating dairy merit of individual cows. The problem of a suitable biological measure of comparative dairy merit is complex. For present purposes we may examine four formulas based on milk energy yield and live weight of cow. Using symbols as above, page 583, the four formulas may be set up as follows:

$61FCM/(FCM + .173W^{.73})$	vs.	$155\ FCM/W^{.73}$	1 vs. 1a
vs.		vs.	vs. vs.
$53FCM/(FCM + .0242W)$	vs.	$1000\ FCM/IW$	2 vs. 2a

All these formulas may properly be regarded as energy-size indexes or efficiency formulas. Formula 1 is advocated by the Missouri Station (2, 3, 4) as an estimate of the percentage ratio of milk energy yield to digestible feed energy consumed, which ratio is regarded as ''unquestionably the only proper index of physiologic dairy value'' (9, p. 29). Formula 1a is suggested by Dr. Brody (correspondence) as an alternative to formula 1. After the general idea of Jordan (12) formula 2 was used by the writer (5) as an indirect estimate of efficiency to indicate the economic or social significance of annual milk energy yield per unit of live weight. It was later (6, 7, 8) modified to the simple and direct relation of formula 2a. In formula 2a it is considered essential to deal: A, with FCM for a suitable, uniform interval of the lactation period (such as the first 8 months of the lactation); and B, with initial live weight (IW). Prescription A applies with equal force to any biological measure of comparative dairy merit. Prescription B is designed to provide uniformity in taking live weights— at a very yield-significant stage of the reproductive cycle and in a manner readily workable in practice.[6]

In a general way, formulas 1, 1a, 2, and 2a are more like than unlike. But in technical detail and implication there are important differences. These may be brought out by numerical example, as in Tables 4 and 5. For simplicity it is considered that $IW = W$, that is $\triangle W = 0$.

Table 4 uses as example 1000-pound cows at variable FCM's or productive levels. Comparing formulas 2 and 2a it is clear that formula 2 tends to accentuate the difference between cows at low levels, and obliterate the difference between cows at high levels. As a direct expression of dairy merit it is clearly desirable, for instance, to recognize an increase from $FCM = 80$ to $FCM = 100$ at least as prominently as an increase from $FCM = 20$ to $FCM = 40$. On this count alone formula 2a must displace formula 2 as a direct measure of comparative dairy development.

Physiologically the relation represented by formula 2 or the percentage ratio of milk energy to digestible feed energy[7] is an incidental result of the

[6] In commercial use it may be necessary to take IW at the first visit of the tester after the cow freshens. (This system is under trial in a few Illinois Dairy Herd Improvement Associations at the present time.) Another object of using initial live weight is that it tends to discount the yield influence of fatness at calving. For example, if a given cow may weigh either 1000 pounds or 1100 pounds after calving, according to condition of flesh, and if in 1100-pound condition her FCM is 10 per cent greater than in 1000-pound condition, then formula 2a perfectly discounts fatness at calving. Still another object of using IW is that it tends to make formula 2a more independent of age of cow at calving than would W or $W^{.73}$. The use of IW ignores $\triangle W$, except as $\triangle W$ may be correlated with gain in weight during the preceding calving interval. However, $\triangle W$ may be of itself an important index of dairy merit in connection with the given environment (feed).

[7] In commercial use it is not practical to determine the actual digestible feed energy consumed by the individual cow, hence the attempt to estimate the ratio of milk energy to feed energy by formula 1 or 2. While this ratio is very significant from the artificial

more primary relation FCM/W represented by formula 2a. As a direct biological measure of dairy merit it is better to use the simple primary relation FCM/W in some form, such as formula 2a.

The comparison of formulas 1 and 1a is similar to that of formulas 2 and 2a.

In Table 5 we have to consider the proposition of dealing with IW or with W^{73}. The examples show that, relatively, the use of IW favors the small cow while the use of W^{73} favors the large cow.

Formula 1a is based on the broad theory that, as between individual animals of any or all warm-blooded species, physiologic weight (13) or active tissue (in distinction from supporting or relatively inactive tissue) is proportional to $W^{.73}$; working maintenance (2) is proportional to W^{73}; and (in the cow at least) udder size (14, p. 13) or potential milking capacity is proportional to W^{73}. Formula 2a is based on the narrow theory that, for practical purposes, as between individual dairy cows within a live-weight range of 600 to 1800 pounds, each of these three items may be considered proportional to initial live weight (IW).

TABLE 4

Comparison of energy-size indexes, or efficiency formulas, when $W = IW = 1000$ and FCM is variable

	FCM =	0	20	40	60	80	100
Formula 2a, 1000FCM/IW	=	0	20	40	60	80	100
Formula 1a, 155FCM/W^{73}	=	0	20	40	60	80	100
Formula 1, 61FCM/(FCM + .173W^{73})	=	0	26	37	42	46	48
Formula 2, 53FCM/(FCM + .0242W)	=	0	24	33	38	41	43

TABLE 5

Comparison of energy-size indexes, or efficiency formulas, when FCM/W is constant and $W (= IW)$ is variable

	W = IW =	600	800	1000	1200	1400	1600	1800
	FCM =	12	16	20	24	28	32	36
Formula 2a, 1000FCM/IW	=	20	20	20	20	20	20	20
Formula 1a, 155FCM/W^{73}	=	17	19	20	21	22	23	23
Formula 1, 61FCM/(FCM + .173$W^{.73}$)	=	24	25	26	27	27	28	28
Formula 2, 53FCM/(FCM + .0242W)	=	24	24	24	24	24	24	24
	FCM =	60	80	100	120	140	160	180
Formula 2a, 1000FCM/IW	=	100	100	100	100	100	100	100
Formula 1a, 155FCM/W^{73}	=	87	94	100	105	110	114	117
Formula 1, 61 FCM/(FCM + .173$W^{.73}$)	=	47	47	48	49	49	49	50
Formula 2, 53FCM/(FCM + .0242W)	=	43	43	43	43	43	43	43

standpoint of monetary economy it is of no particular significance from the natural standpoint of species economy. Welfare of the species requires only a very low efficiency in the sense of ratio of milk yield to total feed consumption or FCM/DN. One may question the propriety of calling a high value by any one of the four formulas a high physiological efficiency of the cow; it is rather a high parasitic activity of the mammary gland fostered by man for his own benefit.

The idea that active tissue is proportional to $W^{.73}$ comes from the observed interspecies relation that basal metabolism is proportional to $W^{.73}$. If active tissue is proportional to $W^{.73}$ it follows that the per cent of active tissue is $KW^{-.27}$, that is, the per cent of active tissue varies with W. To illustrate by numerical example, consider a geometric series for W with factor 1/13 (for convenience, since $13^{.27} = 2$) starting with $W = 1690$ (cow) and running to $W = 10/169$ (mouse). Assume in the cow that the amount of body protein, 16 per cent of live weight as found by Moulton (15) is the amount of active tissue. The per cent of active tissue in the 1690-pound cow is then 16, or $119W^{-.27}$. The series becomes:

Illustrative animal	Cow	Goat	Cat	Rat	Mouse
Live weight, pounds, W	1690	130	10	10/13	10/169
Per cent active tissue $119W^{-.27}$	16	32	64	128	256

Does a goat have two times as high a percentage of active tissue as a cow, and does a mouse have sixteen times as high a percentage of active tissue as a cow? The active tissue interpretation of basal metabolism is clearly untenable.[8] It would seem more logical to think that the per cent of active tissue is substantially the same and that rate of activity varies.

Moulton (15) found in cattle the amount of body nitrogen (excluding contents of digestive tract) and the amount of blood to be each a constant percentage of live weight through a wide range of live weights. Body protein and blood volume are two very significant criteria of active tissue and support the use of formula 2a or FCM/IW rather than formula 1a or $FCM/W^{.73}$.

Whether working maintenance is in fact proportional to IW as contemplated by formula 2a or proportional to $W^{.73}$ as contemplated by formula 1a is not clear. Comparing a 1690-pound cow and a 130-pound goat, it seems reasonable to think that the active tissue of each constitutes the same per cent of live weight but that in the goat the rate of activity of the active tissue is twice as great as in the cow, under conditions of complete rest and fast. But that is not to say that the rate of activity continues to be twice as rapid in the goat as in the cow when this minimum metabolism is superseded by the metabolism of locomotion, heavy feed consumption, and heavy work connected with lactation, aside from the work of lactation itself. In other

[8] If we project the series down to a bacterium weighing 10^{-10} mg. we reach the result of 2,000,000 per cent active tissue. While this takes us out of the realm of warm-blooded animals it serves to emphasize the inherent difficulty in expressing the weight of any portion of an organism as proportional to a fractional power of the weight of the whole organism. Thus, by the .73 power philosophy, if the blood of a cow constitutes 5 per cent of her weight the blood of a mouse constitutes 16×5, or 80 per cent, of its weight. Carman and Mitchell (16) have heretofore pointed out that it is absurd to consider the protoplasmic content of animals to be proportional to surface area or the 2/3 power of weight.

words, the fact[9] that basal metabolism is proportional to $W^{.73}$ does not mean that working maintenance must also be proportional to $W^{.73}$. So far as present evidence on working maintenance goes it seems that formula 2a or FCM/IW is justified.[10]

The question of potential milking capacity as proportional to W vs. proportional to $W^{.73}$ is likewise not clear in answer. If we attempt to answer it by finding the regression of FCM on W by statistical analysis of various groups of records of live weight and yield, we get results varying from FCM independent of W to FCM directly proportional to W or IW. For example, the results (unpublished) from certain Red Danish records indicate a small negative correlation between chest girth and annual (fiscal year) yield. On the other hand, the records of Harrison (18, 19) indicate that FCM is almost directly proportional to IW, and the energy-size index, FCM/IW, is substantially independent of initial live weight ($r = -.02 \pm .11$ in the 1930 –31 experiments, and IW = 1062 to 1534).

As a general proposition, however, most records indicate FCM to be proportional to some fractional power of W, perhaps as low as .5, or even lower. The philosophy of formula 1a or FCM/$W^{.73}$ expects more of the large cow than she is now customarily doing, that is, to bring her FCM up to $K_1 W^{.73}$; while the philosophy of formula 2a or FCM/IW carries the expectation still further, up to K_2IW. Any rigorous experimental demonstration of the soundness of either formula 1a or 2a is hardly possible. As before suggested, the philosophy of formula 2a or FCM/IW rests on the conception that in highly bred dairy cows the upper limitation of lactation lies in the sheer work of the energy transformations; the possible work of energy transformation is proportional to the size of the cow machine; the size of the cow machine may be adequately measured in a practical way by initial live weight; the work of lactation is proportional to milk energy yield; hence, FCM/IW measures the degree to which the upper limitation of lactation

[9] The presentation of basal metabolism by Brody, Procter, and Ashworth (17) in their figure 1 to unite many species, from mouse to elephant, in size, by the concise (although empirical) equation $Q = 39.5W^{.734}$ is very impressive, to say the least. It may be noted that such an interspecies equation depends primarily on the mean values of basal metabolism and live weight for each of the several species, and does not necessarily have to hold as between individuals within a species.

[10] The use of live weight in estimating efficiency of milk production is much more simple than its use in estimating efficiency of meat production, because in meat animals the product accumulates in the body for long periods and complicates the situation. If a cow with initial weight of 1000 pounds were to accumulate 10,000 pounds of milk in her body (!), or 1300 pounds of milk solids, during the first 8 months of lactation, an estimate of efficiency from IW as in formula 2a would not be justified. It is probable that initial live weight is normally not far from average live weight for the whole calving interval, perhaps about as close as any single point that could be selected, except for first-calf heifers.

has been attained in the individual cow machine. When lactation reaches the stage of FCM = KIW, formula 2a gives simply DN/1W = Constant (except for changes in live weight).

By the above reasoning small cows are now more highly developed than large ones and the room for improvement is potentially greater in large cows than small ones. On the other hand, "It is much harder to develop a good large cow than it is to develop a good small cow."[11]

SUMMARY AND CONCLUSIONS

Certain records (253) of feed intake, milk yield, and change in live weight give on analysis, $DN'' = .129W^{.60}$, where DN'' is pounds of digestible nutrients per day for working maintenance and W is live weight of the cow, in pounds. Of these 253 records, 172 show a gain in live weight and give $DN'' = .369W^{.45}$; 81 show a loss in live weight and give $DN'' = .021W^{.78}$. It is thought the latter group best warrants the method of analysis. It is concluded the results of the whole analysis are too variable and uncertain to be regarded as necessitating any change in Haecker's $DN'' = .008W$, for dairy cows in milk.

If it is accepted as fact that basal metabolism $= KW^{.73}$, the question is raised as to the soundness of assuming that, consequently, active tissue

[11] The quoted statement was made by Dr. Yapp in discussing the development (breeding, feeding, care) of Illini Nellie as brought out by her "world's record" (20). By formula 2a this cow has an energy-size index of 51 (that is, daily milk energy yield for the first 8 months of lactation = 51 pounds of four per cent milk per 1000 pounds initial live weight), the highest of any cow in the herd under the present practice of uniform, suitable environment; she is also the largest Brown Swiss cow in the herd. The three items, 1000FCM/IW = 51, IW = 1690, and fat percentage = 4.02, give a significant summary of her dairy development for the given lactation and environment. It is held that as between individuals in a large population of highly bred dairy cows (any breed or breeds, age or ages) under good conditions of management, these three items are mutually independent. It is recognized that in the present stage of development of dairy cattle a negative correlation between IW and FCM/IW will appear in many instances. It is held that this is not inherent in the possible development, but rather represents the greater difficulty (genetic and environmental) of fully developing the potenialties of the large cow, as compared with the small one; and also, the lesser necessity of doing so from the standpoint of monetary profit per cow per year (9). As the yield of dairy cattle is developed from the present, say $FCM = K_1W^{.5}$, to the possible $FCM = K_2IW$ of formula 2a, we shall frequently find a more or less close approximation to $FCM = K_3W^{.73}$. Relatively, $FCM = K_2IW$ is a difficult goal for the larger cows and the dairyman whose pasture and feed conditions are abundant enough to be adapted to large cows may profitably (9) use them, even at a lower rating by formula 2a. The record should include size of cow in absolute terms, in addition to its use in an efficiency formula. To fit his particular individual condtions the dairyman may want a large cow or he may want a small cow, he may want a high-fat-percentage cow or he may want a low-fat-percentage cow, but he always wants a cow of high efficiency as gauged by formula 2a or FCM/IW.

$= K_1 W^{.73}$ working maintenance $= K_2 W^{.73}$, or potential milking capacity $= K_3 W^{.73}$.

The bearing of the working maintenance and live weight relation is discussed in comparison of four energy-size indexes or efficiency formulas. For practical utility as a biological measure of comparative dairy development preference is expressed for the formula FCM/IW in which FCM is milk energy yield for some suitable uniform period (such as the 3d–245th days) of the lactation, and IW (initial weight) is live weight of the cow at the start of the period.

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OXIDIZED FLAVOR IN MILK

V. THE EFFECT OF METAL–DEVELOPED OXIDIZED FLAVOR ON THE IODINE NUMBER OF THE MILK FAT

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It is generally believed that the oxidation of milk fat occurs at the double bonds of the unsaturated fatty acids. For this reason any appreciable oxidation of milk fat, as the result of oxidized flavor development in milk, might be expected to cause a reduction of its iodine number. In fact such reductions already have been reported by Kende (7) and by Dahle (2). Kende, after showing that milk fats extracted from milk with ether showed the same iodine numbers as those prepared by separation, churning and rendering, proceeded to prepare the fats by the ether extraction method. His results showed iodine number decreases of between 10.5 and 32.4 per cent as the result of the artificial production of oxidized flavor through the use of 4 mg. of metal (presumably copper) per liter. He found reductions of iodine number, as the result of spontaneous development of oxidized flavor, of between 11.9 and 14.1 per cent. Dahle, in a progress report which does not give any actual data, has stated that the iodine number decreases in proportion to the degree of flavor present.

When the authors made an incidental check of the effect of oxidized flavor development in milk on the iodine number of its fat the results were at such variance with those reported by Kende that the experiment herein reported was conducted.

EXPERIMENTAL

Collection and Preparation of Samples

All of the milk used in this experiment was from cows known to be producing milk that was susceptible to oxidized flavor development. The milk was drawn into aluminum pails and poured directly into a ten-gallon aluminum can, omitting the usual straining operation because the strainers available at the time this work was done had exposed copper surfaces which came in contact with the milk that was passed through them. The milk was brought to the laboratory immediately and pasteurized at $143 \pm 1°$ F. for 30 minutes. Pasteurization was accomplished by immersing the can in water in a vat fitted with a cold water inlet, a steam coil for heating, and an overflow pipe. The milk was agitated by means of a glass rod. Approximately 20

minutes were required to raise the milk to pasteurization temperature and 30 minutes were required to lower the temperature of the milk to 50° F. following the holding period.

When the milk had been cooled it was thoroughly stirred and divided equally between two aluminum cans by pouring.   One of the cans had copper added to it in a concentration of 1.3 parts per million from a solution of copper sulphate, whereas the other served as a control.   Both cans were immersed in ice water, and then stored in a cold room at 40° F. ± 5° for three days.   This procedure had been shown previously to produce an oxidized flavor in milk contaminated with copper.

At the end of the storage period both samples were removed from the cooler, and flavor determinations were made by tasting.   They were then warmed to 100° F. and separated.   Each sample then was subjected to the following procedure.   The cream was divided into two lots, half of it being cooled and churned in a small glass churn and the remainder being washed by repeated dilution with water at 115° F. ± 5° and then reseparated until the fat "oiled off."   This usually required from 14 to 20 separations.   Butterfats prepared in this way have been found to be free from phospholipids (9).   The fats from the butteroils and from the samples of butters were

TABLE 1
Iodine number determinations on replicate samples of one fat

TRIAL NO	IODINE NO	AVERAGE
1	26.8 26.9 26.9	26.9
2	27.1 26.8 26.5	26.8
3	26.8 26.7 26.8	26.8
4	26.9 27.0 27.0	27.0
5	27.1 27.0 26.9	27.0
6	26.9 26.9 27.0	26.9

	Lowest	26.5	Lowest	26.8
	High	27.1	High	27.0
	Difference	0.6	Difference	0.2

placed in Hart casein tubes, melted in a water bath at 110–120° F., and centrifuged in an electrically heated Babcock centrifuge for 15 minutes. After centrifuging, the fat was transferred to dry sample bottles by decantation, care being taken not to pour off any water or curd collected in the base of the tube. The samples then were ready for iodine number determination.

Determinations on Replicate Samples

In order to find the amount of variation which normally could be expected in replicate determinations the iodine number of one fat was determined in triplicate in each of six individual trials. The results are shown in Table 1.

The widest variation between any two determintions was 0.6 of a unit, while the widest variation between the means of any two triplicate trials was 0.2. These results indicate that the iodine numbers of any two individual samples must differ by at least 0.2 to 0.6 of a unit before any difference in the degree of saturation of the fats would be indicated.

Determination of Iodine Numbers of Experimental Samples

The iodine number was determined in seven series of experimental samples during the latter part of 1935 and the early part of 1936. The values are shown in the first part of Table 2. The results of this experiment show quite conclusively that there was no decrease in iodine number when oxidized flavor was produced.

Because these results were at variance with those reported by Kende and by Dahle, it was decided that the experiment should be repeated about a year later. The same technique used the previous year was employed except that the iodine numbers were determined in duplicate by another worker who had no knowledge as to the identity of the samples. The results are shown in the latter part of Table 2. Here, also there was no measurable difference between the fats from oxidized and normal milks as shown by the iodine number. It would have been desirable to have had iodine number determinations on samples of fat from milk which spontaneously became oxidized in flavor, without the addition of copper, but unfortunately there were no cows in the Experiment Station herd producing such milk.

<div style="text-align:center">DISCUSSION</div>

The authors are unable to explain the direct contradiction of Kende's results and Dahle's report shown by these experiments. It seems possible that an oxidized flavored milk which becomes very strongly oily might have had its butterfat oxidized, whereas, in a mildly oxidized flavored milk, the oxidation may have affected only the substance or substances of the adsorbed layers on the fat globules as postulated by the authors in previous publications (9) (10). Occasionally small dosages of copper added to milks of individual cows in the Station herd have caused development of strongly oily

TABLE 2

Iodine numbers of fat from butter and butteroil from milk showing oxidized and normal flavor

DATE	FAT FROM BUTTER — Normal Determination	Average	Flavor	Oxidized Determination	Average	FAT FROM BUTTEROIL — Normal Determination	Average	Flavor	Oxidized Determination	Average	FLAVOR OF OXIDIZED SAMPLE*
12/25/35	26.6 26.6 26.8 26.7	26.7		26.8 26.9 27.0 26.7	26.9	26.8 26.7 26.8 26.9	26.8		26.4 26.4 26.9 27.0	26.6	3
12/26/35	26.8 26.9 26.8	26.8		26.6 26.6 26.9	26.6	26.7 26.8 27.2	26.8		27.2 27.4 26.9	27.2	4
12/27/35	26.8 26.3	26.6		26.8 26.8	26.8	27.0 26.9	27.0		26.8 27.1	26.9	3
12/28/35	27.7 27.6 27.7 27.4	27.7		27.7 27.7 27.7 27.7	27.7	27.8 28.0 27.9 27.3	27.9		27.7 27.5 27.5 27.5	27.6	3
12/29/35	27.4 27.7 28.4	27.5		27.5 27.5 28.3	27.6	27.4 27.6 28.1	27.4		27.7 27.6 28.3	27.6	4
12/30/35	28.4 28.3 27.4	28.4		28.4 28.4 27.4	28.4	28.1 28.1 27.3	28.1		28.3 28.4 27.4	28.3	4
1/1/36	27.4 27.3	27.4		27.4 27.3	27.4	27.2 27.2	27.2		27.5 27.3	27.4	4
2/17/37	29.8 29.9	29.8		30.0 29.9	30.0	29.7 29.6	29.7		29.6 29.6	29.6	3
2/18/37	29.9 30.1	30.0		30.3 30.2	30.3	30.0 30.0	30.0		29.9 29.8	29.9	4
2/20/37	28.9 28.9	28.9		29.2 29.3	29.3	29.5 29.4	29.5		29.2 29.3	29.3	3
2/21/37	28.9 28.8	28.9		28.9 28.8	28.9	28.5 28.4	28.5		28.7 28.8	28.8	4
2/22/37	29.0 29.0	29.0		29.1 29.3	29.2	29.3 29.3	29.3		29.0 29.0	29.0	4

* Meaning of symbols: 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor.

Note: No oxidized flavor in normal samples.

flavors. Such milks may have been available to Kende and to Dahle for their work, but only moderately oxidized flavor developed in the milks studied in the experiments herein reported.

Because a finding that iodine numbers of milk fat decrease as oxidized flavor develops would indicate an oxidation of the fat itself it would seem fair to draw analogies with results relating to butter. Thus, although it has been shown by Greenbank and Holm (3), and others, that tallowy flavor does not become evident in the butterfat until after the end of the induction period and the beginning of rapid, logarithmic oxygen absorption, yet Henderson and Roadhouse (4) have found that the milk fat of oxidized flavored milk had passed only a fraction of its induction period. If we add the results of Holm and Greenbank (5) showing that the iodine number of butterfat did not change appreciably during oxidation until after the end of the induction period, and indeed not until after considerable oxygen had been absorbed, it would appear that oxidized flavor development in milk should not be expected to cause a change in the iodine number of its fat unless the oxidation had progressed considerably further than was the case with the milks studied by Henderson and Roadhouse

The question arises, if the milk fat is not the constituent oxidized when mild or moderate oxidized flavor occurs, what constituent is oxidized? The previous work of the authors (9) (10) has indicated that the lecithin of the adsorbed layers on the fat globules is the constituent affected. However, other substances in the fat globule adsorbed films should not be overlooked. There is a possibility that cephalin may contribute to this behavior since the substance obtained from dry buttermilk and referred to as lecithin in the previous work (8) without doubt was a mixture of at least lecithin and cephalin.

If lecithin were the constituent oxidized it would be impossible to detect a change in iodine number as a result. Assuming that the lecithin molecule contains as the two fatty acid radicals one molecule of oleic acid and one molecule of stearic acid, the molecular weight was calculated to be 805. Since oleic acid has one double bond it would absorb 2×126.93 or 253.86 grams of iodine per mole of lecithin present. On this basis the calculated iodine number of lecithin would be 31.54, $\left(\dfrac{253.86}{805} \times 100 = 31.54 \right)$. Horrall (6) gives the average lecithin content of fat from sweet cream butter as 0.232 per cent. But the lecithin in the butter replaced fat which in the case of the latter experiments had an iodine number of approximately 29.00. Butterfat with 0.23 per cent lecithin would have a calculated iodine number of 29.01.

According to this calculation an increase of only 0.01 of a unit of iodine number could be expected from the presence of 0.23 per cent lecithin in the sample. In this calculation it was assumed that lecithin contained only one

double bond capable of taking up iodine; if, however, lecithin contained as many as ten double bonds its oxidation still could not be determined by means of iodine numbers under the present conditions of accuracy of the method, and the small proportion of lecithin present in butterfat.

SUMMARY

In twelve trials during winter months of two successive years no measurable change in the iodine number of milk fat could be found as the result of the development of moderate or fairly pronounced oxidized flavor. It is shown by calculation that oleo-stearo lecithin in quantities usually found in sweet cream butter could not affect a measurable change in iodine number even though the double bonds of the oleic acid were completely oxidized. The evidence that the milk fat itself is not affected when oxidized flavor develops indicates that some other constituent of milk is the one in which the off-flavor arises when moderate to fairly pronounced oxidized flavor is produced.

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THE ELECTROKINETIC POTENTIAL OF MILK FAT[1]

II. RELATION TO DAIRY PROCESSES

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The repulsive force, or lack of it, among fat globules resulting from the electrokinetic potential at the surface has often been mentioned as an important factor in certain dairy processes in which clustering or aggregation of globules is important. The experiments described in this paper were planned to show the importance of this factor in such dairy processes.

HISTORICAL

The formation of a maximum cream layer on bottled milk is a matter of much commercial importance as is well known. The advent of commercial pasteurization introduced many problems connected with the effect of heat on the creaming ability of milk. It is generally recognized that the usual pasteurizing temperatures of market milk are not detrimental to creaming, but they represent the upper limits before reduction of creaming occurs. Babcock and Russell (1) in 1896, and Farrington and Russell (2) in 1899, were among the first to recognize this fact. Dahlberg and Marquardt (3) (4) have presented an excellent review of work in this field. The work of several investigators, and in particular Troy and Sharp (5), has shown that clustering of fat globules is essential to rapid and exhaustive creaming. The failure of fat globules to cluster in milk which has been heated above a certain point results in a reduction in the cream volume.

It remains to be shown what factors are important in promoting or preventing clustering. Palmer and Anderson (6) have shown that addition of milk albumin which increased the viscosity of the milk plasma accelerated creaming, while the addition of casein inhibited creaming. Rahn (7) suggests that this is caused by the heat inactivation of the sticky colloidal layer surrounding the fat globule. Sirks (8) found no apparent relation between creaming and the electrokinetic potential of the fat. In contrast to this, Dahlberg and Marquardt (3) have offered an explanation embracing an alteration in the magnitude of the charge on the particles. Numerous attempts by Hammer (9), Troy and Sharp (5), and others to promote clustering by altering the zeta potential through additions of electrolytes have been effective.

Creaming of Milk

Three series of experiments were made. In series 1 whole milk was heated to different temperatures with some of it held for 30 minutes and some of it cooled after 15 seconds, table 1. In series 2 skim milk was heated similarly and raw cream added after cooling to make a four per cent milk, table 2, and in series 3, 60 per cent cream was heated in the same manner and raw skim milk added after cooling to make a four per cent milk, table 2. Samples were held at 38° F. in creaming cylinders for 24 hours at which time the cream volumes were measured. The readings are expressed as cream volume percentage per one per cent fat content of the milk. Electrophoretic mobilities of the fat globules were determined by the method described in a previous paper (10).

TABLE 1

The effect of heating whole milk (series 1) on cream volume and electrophoretic mobility of the fat globules

TEMPERATURE °F.	TIME HELD	CREAM VOLUME/ % FAT	MOBILITY μ/SEC/V/CM
	min.		
Unheated		4.01	2.56
110	30	3.98	2.56
120	30	3.86	2.57
130	30	4.06	2.55
140	30	3.90	2.68
150	30	2.50	3.15
160	30	0.62	3.52
	sec.		
110	15	4.06	2.55
120	15	3.91	2.57
130	15	4.04	2.56
140	15	4.01	2.54
150	15	3.91	2.60
160	15	3.23	2.75
170	15	0.72	2.92
180	15	0.69	3.04

The writers are aware of the possibilities of irregularities resulting from applying a relatively high heat to small quantities of cream, and any tendency toward inconsistency in the results is explained on that basis.

It was observed in these experiments that when the cream volume was reduced by the heat treatment the cream layer which formed was higher in fat than when the creaming was normal. Table 4 shows the results of a typical experiment in the relation between cream volume and fat content of the cream layer.

TABLE 2

The effect of heating skim milk on cream volume and electrophoretic mobility

TEMPERATURE °F.	TIME HELD	CREAM VOLUME/ % FAT	MOBILITY μ/SEC/V/CM
	min.		
Unheated		4.10	2.55
110	30	4.00	2.56
120	30	4.05	2.57
130	30	3.90	2.55
140	30	3.75	2.54
150	30	1.80	2.56
160	30	1.20	2.55
	sec.		
120	15	3.95	2.54
130	15	4.00	2.55
140	15	4.00	2.55
150	15	4.05	2.53
160	15	1.05	2.56
170	15	0.50	2.54
180	15	0.50	2.55

TABLE 3

The effect of heating cream on cream volume and electrophoretic mobility

TEMPERATURE °F	TIME HELD	CREAM VOLUME/ % FAT	MOBILITY μ/SEC/V/CM
	min.		
Unheated		4.00	2.56
110	30	4.05	2.55
120	30	3.80	2.55
130	30	3.80	2.54
140	30	3.60	2.61
150	30	3.70	3.05
160	30	3.85	3.55
	sec.		
120	15	4.05	2.56
130	15	3.94	2.57
140	15	3.80	2.55
150	15	3.80	2.55
160	15	4.05	2.56
170	15	3.85	2.67
180	15	3.90	3.05

The results of series 1 in which whole milk alone was heated show that the first reduction in creaming occurs above 140° F. when the milk is held for 30 minutes at this temperature. This is the usual observation in commercial practice. Accompanying the cream reduction in this case is a corresponding increase in electrophoretic mobility. In the same series where the holding period was 15 seconds, the decrease in creaming and increase in mobility

TABLE 4

The relation between heat reduction of creaming and the fat content
of the cream layer

TEMPERATURE °F.	TIME HELD	CREAM VOLUME/ % FAT	TEST OF CREAM %
	min.		
Unheated		4.10	23.4
110	30	3.95	23.9
120	30	4.00	23.8
130	30	4.00	27.5
140	30	3.85	29.0
150	30	2.70	34.4
160	30	0.70	46.8

occur at temperatures somewhat under the pasteurization point. This can be explained by the fact that under commercial conditions the heating is almost instantaneous while under the experimental conditions an appreciable time interval elapsed. The results of this series show a decrease in creaming ability and an increase in electrophoretic mobility at temperatures above those used for the vat method of pasteurization.

The results obtained in series 2 where skim milk was heated and raw cream later added show a more marked reduction in creaming at temperatures above the pasteurization point. However, there is no alteration in the electrophoretic mobility of the fat globules. In series 3 where cream was heated and then mixed with raw skim milk, reverse conditions of series 2 resulted; the electrophoretic mobility of the fat globules was increased without a significant decrease in cream volume. This refutes the argument that the increase in the electrokinetic potential of the fat globules is the chief factor in the heat destruction of creaming because the creaming ability of the milk is reduced in the one case without change in the potential, and conversely in the other case the potential is increased without change in the creaming ability.

Furthermore, a consideration of the type of cream layer formed when the creaming ability is reduced by heat reveals the fact that it is different from that expected if the increase in electrokinetic potential were the controlling factor. The argument has been advanced that the increased potential increases the repulsive force among the globules and prevents clumping, thus resulting in a more shallow cream layer. If this were true, the cream layer formed would be lower in fat content than one formed under normal conditions because of the repulsion among the globules. Contrary to this, the opposite condition results in which the cream layer formed, when heat has reduced the creaming ability, has a higher fat content than where normal creaming has taken place. From these data, it appears that alteration in the electrokinetic potential of milk fat globules is not a major factor in heat reduction of creaming.

Homogenization

It is known that homogenization of milk or cream subdivides the fat globules in such a way that under some conditions the resulting smaller particles are grouped together in clumps, and under some conditions the clumps are broken up so that the particles are uniformly dispersed. Sommer (11) states that ice cream mixes which show the greatest degree of clumping are the most viscous and have the poorest whipping ability. Doan (12) calls attention to the fact that in homogenized dairy fluids the protein stability decreases with increasing fat clumping. Sommer again offers the theoretical explanation for the clumping tendency based on the idea that increased clumping is related to a decrease in the electrical charge on the homogenized fat particle. Mohr and Brockmann (13) found that homogenization had no effect on the value of the isoelectric point of the fat globules in whole milk.

It is the general observation that single stage homogenization at 150° F is conducive to clumping of fat globules and dual homogenization at the same temperature tends to inhibit clumping. In this study whole milk and two samples of cream of different fat contents were used. Each was heated to 150° F. and divided into two portions. One portion of each was homogenized with a single valve under 2000 pounds pressure and the other portion was homogenized by dual homogenization using 2000 pounds pressure on the first valve and 500 pounds pressure on the second valve. Samples were examined for clumping and electrophoretic mobility. The results are shown in Table 5.

TABLE 5

The effect of homogenization on clumping of fat globules and electrophoretic mobility

LOT NO.	FAT PER CENT	POUNDS PRESSURE		GLOBULE SIZE MICRONS	DEGREE OF CLUMPING	MOBILITY μ/SEC/V/CM.
		Single	Double			
1	4.2	2000	0	1.5	+	2.65
2	4.2	2000	500	1.5	−	2.68
3	21.0	2000	0	1.5	+++	2.65
4	21.0	2000	500	1.5	−	2.65
5	36.0	2000	0	2.0	+++	2.65
6	36.0	2000	500	1.5	−	2.64

In lots 3 and 5 the clumps averaged about 20 microns in diameter and migrated with the same velocity as the individual globules. The mobilities of the globules correspond to those of normal milk heated to 150° F. It is apparent that the degree of clumping is independent of the electrophoretic mobilities of the globules.

SUMMARY AND CONCLUSIONS

Cream volume studies and electrophoretic mobility measurements of fat globules were made on milk heated to different temperatures in the following manner: whole milk heated, skim milk heated and raw cream later added to

make a four per cent milk, and cream heated and skim milk added later to make a four per cent milk.

The creaming ability was reduced when whole milk and skim milk were heated separately above the pasteurization point.   The creaming ability was not affected when cream alone was heated and made into four per cent milk with raw skim milk.

The electrophoretic mobility of fat globules was increased when whole milk and cream were heated above the pasteurization point.   The mobility was not affected when skim milk was heated and made up with raw cream.

The fat content of the cream layer increased as the cream volume was reduced by heat.

Neither single stage homogenization accompanied by fat clumping nor double stage with no clumping of fat globules had any effect on the electrophoretic mobility of the fat globules.

The electrokinetic potential is not an important factor in the creaming of pasteurized milk.

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CHEMICAL CHANGES IN THE MAKING OF A.I.V. ALFALFA SILAGE AND NUTRITIVE QUALITIES OF MILK PRODUCED THEREFROM[1]

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LITERATURE REVIEW

Numerous papers have appeared in recent years regarding the preservation of plant forages by ensiling them with mineral acids. The most widely used of these methods is known as the A.I.V. method and reports regarding its use have come from both foreign and American investigators (1–15). In general the claim that forages, especially legumes, ensiled by this method show less loss of protein, carotene and total nutrients than untreated forage appears to be well substantiated. The development of a butyric type of fermentation with its accompanying production of ammonia and objectionable odors is prevented by acidifying the plant tissue to a pH of about 3.5. At this low pH a lactic type of fermentation takes place with but little decomposition of protein.

In a previous publication (14) experiments were reported dealing with the fermentative changes, the preservation of protein and carotene, and the effect upon cows of feeding alfalfa ensiled by the A.I.V. method. Because of the variable conditions encountered in silage making, it was considered advisable to repeat the previous experiments and to enlarge upon certain phases of them. Greater emphasis was placed upon the study of the fermentative changes in the silage and upon certain aspects of the feeding trials. In order to throw some light on the fermentative changes as well as to study the progressive changes in nitrogen distribution and carotene content, several small lots of silage were preserved in barrels with and without the addition of acid.

PART I. PREPARATION AND COMPOSITION OF SILAGE

Preparation and Analysis.—Forty-two tons of alfalfa were ensiled in June, 1934, in the same silo and in the same manner as the second lot of alfalfa described in our previous publication. The alfalfa was pitched into

the top of the silo from an elevated driveway without being cut up, and 100 liters of 2N acid, containing 40.2 lbs. of commmercial HCl (18° Be) and 7.9 lbs. of commercial H_2SO_4 (65° Be), were added to each ton of green forage. In our previous experiment 120 liters of acid were required but the alfalfa used in the present experiment was longer stemmed and more succulent than that put up in the preceding year.

When the silo was full, 100 cc. of an emulsion of mustard oil (allyl-iso-thiocyanate) was added with the last portion of acid, and the silage was covered with tar paper, shavings, and soil as recommended by Virtanen and as described in our earlier paper. The drainage juice was collected as previously described.

The fresh plant material and silage were analyzed for dry matter, total nitrogen, total water soluble nitrogen, amino nitrogen, ammonia nitrogen, and carotene as in the previous work. Determinations of fermentation products by methods already described (16) and numbers of bacteria by counts on glucose yeast-extract agar plates were also made on the silage twice during the emptying of the silo.

At the time that the silo was filled six barrels were filled with some of the same alfalfa. For this purpose the alfalfa was chopped in a silage cutter. Acid was added to five of the barrels in the same proportion as to the contents of the silo, and the sixth barrel was left as a control with no acid. The barrels were carefully packed full of the chopped alfalfa, headed up, and sealed with paraffin. The barrels containing A.I.V. silage were opened after intervals of 5, 12, 23, 37, and 155 days, respectively. The control barrel was also opened after 155 days. Determinations of the number of microorganisms, the fermentation products formed, and the changes in carotene content were made on the contents of all the barrels, and in the case of the control barrel and the last two barrels of acidified silage to be opened, nitrogen distribution was also studied.

RESULTS AND DISCUSSION

There was considerably less drainage from the silo in this experiment than in the preceding one. In 1933 the volume of drainage was 1,480 liters containing the equivalent of 237 liters of 2N acid, or 11.4 per cent of the 2,075 liters of 2N acid added in the preparation of the silage. In 1934 the volume of drainage was 1,640 liters containing the equivalent of 218 liters of 2N acid or 5.1 per cent of the 4,280 liters of 2N acid added in the preparation of the silage. That only about half as much acid ran out in the second experiment as in the first probably was due to the smaller quantity added and to a greater amount of drying of the alfalfa in the field. Drainage was reduced also by adding less than the calculated quantity of acid to the first 3 loads of alfalfa put into the silo.

Table I summarizes some of the changes occurring in the alfalfa. In

TABLE I
Analyses of green alfalfa and A.I.V. alfalfa silage

	PLANT MATERIAL	SILAGE	
		After 6½ months. Near top of silo	After 11 months Near bottom of silo
pH		3.6	3.5
Dry matter, per cent	25.5 – 38.0	28.5	30.0
Total nitrogen, dry basis, per cent	2.80	2.69	2.87
Water soluble nitrogen			
Dry basis, per cent	0.76	1.53	1.81
Basis of total N, per cent	27.1	56.8	63.1
Amino nitrogen			
Dry basis, per cent	0.35	0.71	0.87
Basis of total N, per cent	12.4	26.3	30.4
Ammonia nitrogen			
Dry basis, per cent	0.013	0.14	0.28
Basis of total N, per cent	0.46	5.3	9.7
Carotene, dry basis, micrograms/gm.	90	156	117
Volatile acids, as acetic, dry basis, per cent		1.67	2.24
Non-volatile acids, as lactic, dry basis, per cent		5.84	5.27
Lactic acid, dry basis, per cent		1.17	3.04
Alcohol, as ethyl, dry basis, per cent			0 70

general these changes are the same as those observed in the previous experiment except that there was an increased formation of ammonia. In the work previously reported the ammonia nitrogen constituted from 0.2 per cent to 1.0 per cent of the total nitrogen in fresh plant material and from 1.0 per cent to 1.7 per cent of the total nitrogen in the silage, while in this experiment the ammonia nitrogen made up 0.46 per cent of the total nitrogen in the fresh alfalfa, and 5.3 per cent and 9.7 per cent of the total in the two samples of silage analyzed. The latter figure was obtained on a sample taken from near the bottom of the silo and might very easily have been affected by drainage downward of ammonia. The figures for water soluble nitrogen and amino nitrogen were also higher in this sample, though the difference was less marked than in the case of the ammonia. It is difficult to explain this increased ammonia formation, since the pH was at the desired level throughout the silo, except for one figure obtained on a sample taken from near the top at the time the silo was opened. The pH at this point was 4.0, and there was a layer several feet thick of partially spoiled material at the top. As stated above, the alfalfa was very coarse and long-stemmed, and this fact may have slowed the process of settling and packing of the silage and so allowed this spoilage at the top. The increased ammonia content lower down may have been another manifestation of delayed settling and packing or it may have been the result of downward drainage of ammonia

from the spoiled material at the top.   As in the previous experiment, there was a substantial increase in water soluble nitrogen and amino nitrogen over the amounts found in the fresh plant material, but these increases do not, of course, necessarily represent losses in feeding value, since much of the water soluble and amino nitrogen may be available to the animal.   The figures for carotene, as in the preceding year's work, were distinctly higher in the silage than in the fresh alfalfa, but, as will be explained later, it is doubtful that these increases represent carotene.

In general the data on fermentation agree with the data obtained in the previous experiment.   The amount of non-volatile acid was considerably greater than the amount of volatile, but probably only the lactic part of the non-volatile acid was of fermentation origin.   The other part of the non-volatile acid probably consisted of citric, malic and other plant acids.   The alcohol content of the silage was approximately that formed in corn silage (17).

The presence of large numbers of bacteria during the ensiling period is indicated by the presence of these fermentation products.   Direct evidence on this point was obtained by plate counts of the silage taken about one foot below the surface in order to avoid the presence of any organisms growing on the surface or deposited from the air.   Samples were taken several times during the feeding period and gave counts of about 20 million per gram of silage.   Such numbers do not give any indication of the maximum popula-
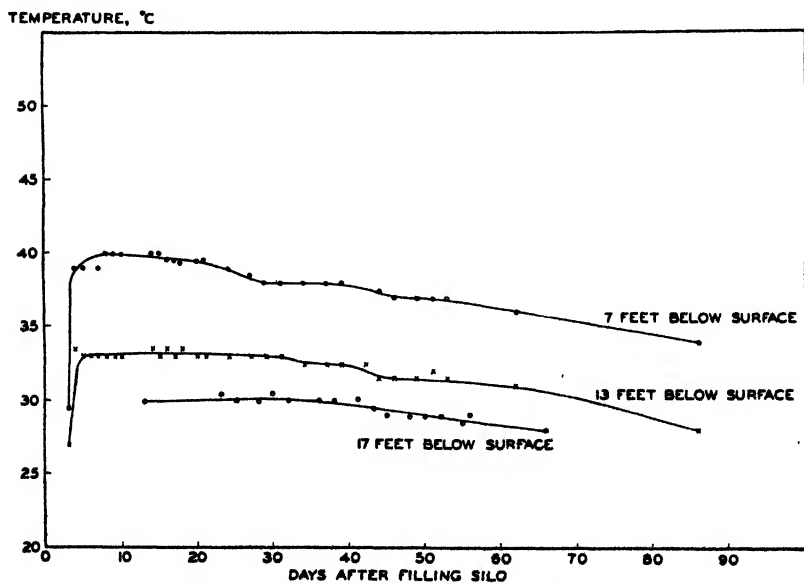
FIG. 1.   TEMPERATURE CHANGES IN THE SILAGE.

tion at the height of fermentation but only those that persist after most of the fermentation is over and conditions have become more or less stable. From data on the barrel silage, populations equal to 200 million per gram were found in the early stages of fermentation.

Figure 1 shows the temperature changes at three different levels in the silo. At levels seven feet and thirteen feet below the surface there was a very quick rise in temperature followed by a slow decrease. Temperatures were higher at higher levels in the silo, the maximum being 40° C. seven feet below the surface, 33½° thirteen feet below, and 30½° seventeen feet below. This inverse relation between temperature and depth was found by Peterson, Hastings, and Fred (17) to obtain also in the formation of corn silage. The alfalfa was put up during a period of very hot weather and therefore the green forage was warm at the time it went into the silo. Cell respiration was also high and was probably not checked by the added acid before the temperatures recorded had been reached

TABLE II
Data on Barrel Experiments

	PLANT MATERIAL	A I V SILAGE		ENSILED WITHOUT ACID AFTER 5 MONTHS
		After 5 weeks	After 5 months	
pH		3.7	3.67	5.20
Dry matter, per cent	25.5	24.2	22.9	21.8
Total nitrogen, dry basis, per cent	2.80	2.65	2.51	2.69
Water soluble nitrogen				
Dry basis, per cent	0.76	1.41	1.32	2.04
Basis of total N, per cent	27.1	53.1	52.6	75.8
Amino nitrogen				
Dry basis, per cent	0.35	0.80	0.66	1.06
Basis of total N, per cent	12.4	30.1	26.2	39.4
Ammonia nitrogen				
Dry basis, per cent	0.013	0.16	0.17	0.69
Basis of total N, per cent	0.46	6.04	6.70	25.6
Carotene, dry basis, micrograms/gm.	90	200	184	126
Volatile acids, as acetic, dry basis per cent		2.80	3.96*	7.75**
Non-volatile acids, as lactic, dry basis, per cent		5.85	4.62	3.16
Lactic acid, dry basis, per cent		2.27	2.40	0.70
Numbers of bacteria, millions/gm. dry matter		36	480	1040

* Acetic, 84%, butyric 16%.
**   "   49%,   "   51%.

In Table II the data on the barrel experiments are summarized. The nitrogen distribution in the two barrels containing acid was much the same as in the silo and there were apparently no very significant changes between

the times that the two barrels were opened. A comparison of the figures for the two barrels containing acid with those for the control barrel shows very strikingly the effect of the acid in the preservation of the proteins. Even though the figures for ammonia nitrogen are rather high for the A.I.V. silage, they are small in comparison to that for the control barrel, in which one-quarter of the total nitrogen was in the form of ammonia. The figures for water soluble nitrogen and amino nitrogen are also relatively high in the control barrel, being respectively 75.8 per cent and 39.4 per cent of the total nitrogen, whereas in the two barrels of A.I.V. silage they were, in the case of the water soluble nitrogen, 53.1 per cent and 52.6 per cent of the total and in the case of amino nitrogen 30.1 per cent and 26.2 per cent of the total.

There appeared to be a progressive increase in carotene which is not shown in this table. The barrel opened after 12 days showed a carotene content of 109 micrograms per gm. as compared with the 90 micrograms per gm. in the fresh plant material. After 23 days this figure had increased to 150 and after 37 days to 200. The figure of 184 micrograms per gm. obtained after 155 days or 5 months is, in view of the difficulties in sampling, not very different from the figure 200. As reported in our previous paper, acid treatment of green alfalfa over a short period of time (12 hours) increased very markedly the apparent carotene content. In many cases this increase amounted to about 50 per cent. It is probable that the slow increase observed in the barrel experiments was due to the same cause. The carotene values of the A.I.V. silage must therefore be taken with a good deal of reservation. Nevertheless because of the high carotene and vitamin A content of the milk produced from this silage it appears that the carotene was well-preserved but that there was an actual increase seems doubtful.

The data on fermentation show that such fermentation as occurred in the acidified silage was of a more desirable type than that occurring in the non-acidified. Volatile acids were very high in the latter, being 7.75 per cent on the dry basis as compared with 2.80 per cent and 3.96 per cent for the two barrels of A.I.V. silage. Conversely, lactic acid was less than one-third as high in the control barrel as in the other two. There apparently was an increase in volatile acids and a decrease in non-volatile acids between the times the two barrels of A.I.V. silage were opened. As the lactic acid did not change materially, it appears that the other non-volatile acids, presumably of plant origin, were slowly destroyed during the fermentation. Bacterial counts made on glucose yeast-extract agar plates indicated that there was a progressive decrease in the number of organisms during the first 5 weeks, but there appeared to be an increase later. The barrel opened after 5 days contained 760 million organisms per gm. of dry matter. After 12 days there were 640 million, after 23 days 264 million, after 37 days 36 million, and after 155 days 480 million. In the control barrel after 155 days there were 1,040 million organisms per gram of dry matter. It is of interest to note that

even at such low pH values as 3.5–3.7 growth of lactic acid-forming bacteria is not inhibited.

PART II.   EFFECT OF FEEDING A.I.V. SILAGE ON THE NUTRITIVE VALUE
OF THE MILK

This experiment was conducted to study further the effect of A.I.V. alfalfa silage over a five months period of feeding, on the nutritive value of the milk, with special reference to the carotene and vitamin A content of the butterfat.

Fourteen dairy cows were chosen from the University herd and divided into two lots of seven cows each, approximately equal in total milk and butterfat production, live weight, period of lactation, and breed.   Each lot consisted of three Holsteins, one Brown Swiss, one Guernsey, one Jersey, and one Ayrshire.   Lot 1, the check lot, was fed a grain mixture of corn 50 parts, oats 40 parts, linseed oil meal 10 parts, steamed bone meal 1 part, and iodized salt 1 part, plus alfalfa hay and corn silage.   The cows were fed one pound of grain for every 3½ pounds of milk produced and one pound of hay and three pounds of corn silage per 100 pounds of live weight.   Lot II, the A.I.V. lot, received a grain mixture of corn 50 parts, oats 50 parts, steamed bonemeal 2 parts, and iodized salt 1 part, plus timothy hay and A.I.V. silage.   Grain was fed at the same rate as in Lot I, hay at one-half the rate in Lot I, and A.I.V. silage was given *ad libitum*.   One ounce of CaCO₃ was fed per ten pounds of A.I.V. silage to neutralize the excess acid.   By making the change gradually no difficulty was experienced in getting the cows to eat the new type of silage.

Besides the above fourteen cows one Guernsey and one Holstein cow were fed the check ration for a long time, five months, and were then changed to the A.I.V. silage ration.   The reversal feeding periods eliminated individual differences among cows and the long feeding period on the check ration, it was expected, would accentuate the effect of the A.I.V. silage on the changes in the milk.

Composite milk samples were collected from each lot at monthly intervals by compositing one quart of milk from each cow at the morning and evening milkings.   The butterfat was prepared as previously described and analyzed spectroscopically for carotene and vitamin A (18, 19).

Since our previous comparison (14) of the A.I.V. silage with pasture was not made with the same cows or immediately after A.I.V. feeding, a direct comparison of these two feeding stuffs was made.   A Guernsey and a Brown Swiss, which had been fed A.I.V. silage for 150 days, were changed to blue grass pasture as the principal source of roughage.   Individual butter samples were analyzed after 19 and 38 days of pasture feeding.

To compare A.I.V. alfalfa silage with green alfalfa, an Ayrshire and a Jersey taken from the A.I.V. lot were fed respectively 39 pounds and 49 pounds of freshly cut green alfalfa daily for six weeks.   These quantities of green alfalfa were equivalent to the same dry matter content as was contained

in the A.I.V. silage consumed by these cows.   At the beginning of the feeding period the alfalfa was somewhat less mature and at the end somewhat more mature than that used for making the acid silage.   The average stage of growth, however, was approximately the same in the two experiments.   The dry matter content was determined weekly on the green alfalfa and A.I.V. silage to asure an equal dry matter intake.   Individual samples of butter were prepared and analyzed as before.

To study the growth promoting quality of the milk produced under different feeding conditions, properly prepared male rats were fed the various milks fortified with iron, copper, and manganese.   Salts of these elements were added to the milk so as to give each rat .5 mg. of Fe, .05 mg. of Cu and .05 mg. of Mn daily.   The animals were fed the milk *ad libitum* and consumption records were obtained by measuring back the unconsumed milk. The animals were kept in individual wire bottom cages and were weighed weekly.   Composite samples of milk from Lots I and II as well as individual samples from cows 4, 5, 6, 7 were tested.   The milks from cows 6 and 7 were tested when they had been on the respective rations for two months and again after four months.   The milk from cow 4 was tested a third time, after she had received green alfalfa for four weeks.   This milk was compared with milks from two other cows that were receiving either green alfalfa or pasture.

To determine whether the rats were receiving sufficient vitamin A, the livers of three rats from each group on the Jersey milks were analyzed.   The vitamin A determinations were made on the unsaponifiable extracts by means of the Carr-Price technique (20).   A solution of $SbCl_3$ in chloroform saturated at 0° was used as a reagent and readings were made on the Lovibond tintometer.   The results were calculated according to the method of Moore (20).

RESULTS AND DISCUSSION

Carotene and Vitamin A Content of Milks

The data in this experiment are in accord with the results obtained in our previous work (14).   The continuous feeding of A.I.V. alfalfa silage during the winter months (December–April) maintained a milk higher in both carotene and vitamin A than ordinary winter milk (Figure 2).   There was a greater increase in the vitamin A than in the carotene content of the milk which is explainable in view of the fact that Holstein, Brown Swiss, and Ayrshire breeds predominated in each group, and these breeds are known (19) to convert a large percentage of their carotene into vitamin A.   The maximum effect of A.I.V. silage was reached within the first 30 days of feeding, and then there was a slight drop to a value which was maintained at a nearly constant level during the remaining part of the experimental period.   Our previous study presented the same condition, which suggests that there is some physiological adjustment on the part of the animal to a large increase in carotene intake.   Watson, Bishop and Drummond (22) observed the same condi-
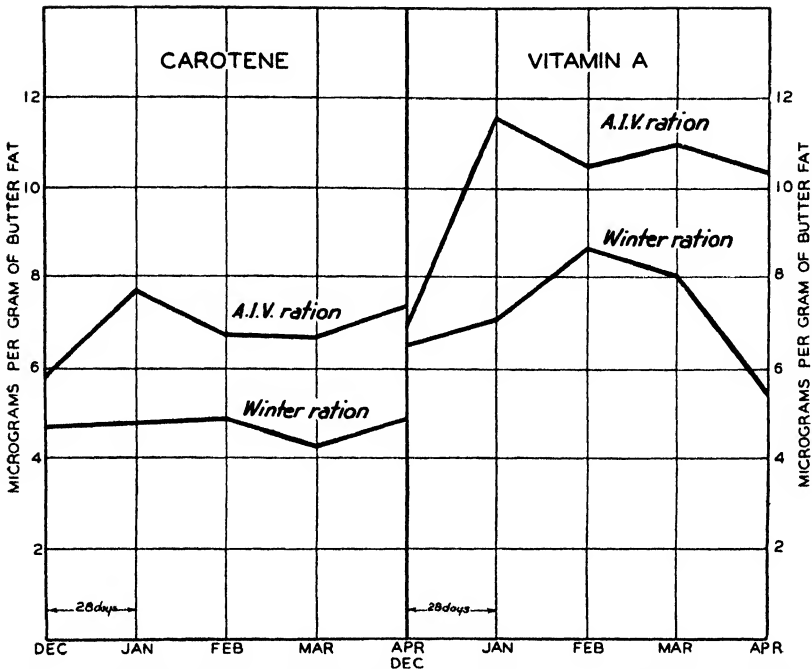
Fig. 2. Effect of ration on the carotene and vitamin A content of butterfat.

tion in their experiments and designated this upper level as a "ceiling" value above which the color and vitamin A content of the butterfat does not rise regardless of the quantity of carotene ingested.

A direct comparison of A.I.V. silage with pasture indicated that butterfat produced on pasture contained from 50 to 100 per cent more carotene and from 30 to 45 per cent more vitamin A than that produced on A.I.V. silage (Table III). Several reasons may account for the fact that pasture is more effective than A.I.V. feeding. First, the carotene intake is no doubt higher because of a larger consumption of green material containing more carotene, and second, the acid treatment of green tissue may change the carotene into an isomeric form that is utilized less efficiently. A recent study in this laboratory has shown that there is a distinct difference in the availability of carotene in various roughages in rations of dairy cows.

Further support of the superiority of fresh green plant tissue to A.I.V. silage was revealed by feeding an Ayrshire and a Jersey green alfalfa on the same dry weight basis as A.I.V. silage had previously been fed for 150 days (Table III). At the end of six weeks of green alfalfa feeding a marked increase was noted in both the carotene (about 50 per cent) and vitamin A (34–103 per cent) content of the butterfat. Although there may have been

Comparison of A.I.V. alfalfa silage with pasture and green alfalfa as to their effect on the Vitamin A content of butter fat

BREED	COW NO.	DAYS ON RATION	RATION	BUTTERFAT	
				Carotene	Vitamin A
				micrograms per gram	*micrograms per gram*
Guernsey	1	150	A.I.V. silage	12.7	6.2
Guernsey	1	19	Pasture	18.5	7.5
Guernsey	1	38	Pasture	19.7	9.0
Brown Swiss	2	150	A.I.V. silage	5.6	7.9
Brown Swiss	2	19	Pasture	13.0	9.4
Brown Swiss	2	38	Pasture	10.4	10.1
Ayrshire	3	150	A.I.V. silage	2.8	8.3
Ayrshire	3	14	Green alfalfa*	3.3	13.7
Ayrshire	3	42	Green alfalfa*	4.4	16.9
Jersey	4	150	A.I.V. silage	7.8	6.5
Jersey	4	14	Green alfalfa*	8.5	7.8
Jersey	4	42	Green alfalfa*	11.6	8.6

* Green alfalfa was fed on the same dry matter basis as A.I.V. alfalfa silage.

a difference in the quantity of carotene ingested, such large increases suggest that the carotene in green alfalfa is more effectively utilized than that in A.I.V. silage.

Growth-promoting quality of various milks

	COW NO.	BREED	RATION	AVERAGE GAIN PER RAT IN 6 WEEKS
Composite milks {	Lot I	Several	Winter	153
	Lot II	Several	A.I.V. silage	161
Individual milks				
March series {	5	Jersey	Winter	122
	4	Jersey	A.I.V. silage	137
	6	Holstein	Winter	141
	7	Holstein	A.I.V. silage	158
May series {	6	Holstein	Winter	142
	7	Holstein	A.I.V. silage	161
	3*	Ayrshire	Green alfalfa	162
	4	Jersey	Green alfalfa	162
	8*	Holstein	Pasture	155
Reversal series {	16	Guernsey	Winter	116
	16	Guernsey	A.I.V. silage	186
	17	Holstein	Winter	156
	17	Holstein	A.I.V. silage	168

' No. 3 had previously been on the A.I.V. silage ration and No. 8 on the check ration.

The results obtained from the studies on the growth promoting properties of the milks produced on the different rations are summarized in Table IV. It is readily evident that the composite samples of milk from both groups gave good growth. If these results are compared with those obtained in 1933–34 (14) we find that this year (1934–35) the results for both the check lot and the A.I.V. lot are equal to those for the A.I.V. group the previous year. This difference cannot be due to any variation in the rats used for assay because milk from other cows on a winter ration fed to similarly prepared rats gave the characteristically poor growth. The only logical conclusion is that the cows in the check lot were receiving in their ration sufficient amounts of the factor or factors in question to render the milk more complete. This lot received alfalfa hay which we know varies in its ability to produce milk of different growth-promoting properties. In spite of the high quality of the milk from the check lot the milk from the A.I.V. group showed somewhat better growth properties.

More marked differences were obtained from studies on individual milks. The results with those from cows 16 and 17 deserve particular attention as the reversal method of feeding was used with these animals and hence differences between individuals were eliminated. Increased gains of from 12 to 20 gm. per rat were observed for the A.I.V. milks. Attention is also called to the greater growth on winter milks of low fat content, i.e., Holstein, than on those of higher fat content, i.e., Jersey and Guernsey. Rats consumed more of the former to satisfy their energy requirement and at the same time ingested more of the growth factor.

That the difference in growth-promoting quality of the two winter milks was not caused by a lack of vitamin A in the control group was shown by the ample storage of this vitamin in the livers of the animals receiving this milk (Table V). Although rats receiving A.I.V. milk stored more vitamin A than animals receiving the control milk, a storage of vitamin A equivalent to 359 blue units per rat liver indicates an abundant supply of this factor in the

TABLE V
Vitamin A storage in rats on winter and A.I.V. milk

LOT	MILK	NUMBER OF RAT	WEIGHT OF RAT	WEIGHT OF LIVER	TOTAL BLUE UNITS PER LIVER	BLUE UNITS PER GRAM OF LIVER
			gm.	gm.		
	Winter	56	226	12.0	374	31.2
I	Winter	57	194	10.4	341	32.8
	Winter	59	182	9.7	363	37.4
				average	359	
	A.I.V.	68	222	7.5	473	63.1
II	A.I.V.	69	218	9.0	550	61.1
	A.I.V.	72	208	9.5	440	46.3
				average	488	

diet. Calculation of the vitamin A intake gave further evidence of the adequacy of the supply. Milk consumption was over 50 cc. per rat per day or slightly over 2 gm. of butterfat. From the data in Figure 2 it can be seen that this quantity of butterfat contained nearly 10 micrograms of carotene and about 15 micrograms of vitamin A. Such an intake of carotene and vitamin A is probably several times the daily requirement even for maximum growth.

SUMMARY

Alfalfa ensiled by the A.I.V. method showed large gains in amino and soluble nitrogen but only small increases in ammonia nitrogen. The carotene value increased but it is doubtful that the increase represents carotene.

Bacteriological platings showed large numbers of microorganisms (10–200 million per gm. of silage) to be present at various times during the fermentation. The production of volatile acids, ethyl alcohol and lactic acid indicated that microorganisms similar to those present in corn silage were active. When the alfalfa was ensiled without the addition of acid, enormous numbers of bacteria developed, and produced large quantities of ammonia and butyric acid.

Feeding of A.I.V. alfalfa silage to dairy cows through the winter months produced a milk with 50 per cent more carotene and 40 per cent more vitamin A than milk produced on a well-balanced winter ration.

Butterfat from cows on pasture contained from 50 to 100 per cent more carotene and about 30 per cent more vitamin A than butterfat produced from A.I.V. silage.

Green alfalfa fed on the same dry weight basis as A.I.V. silage also increased the vitamin A potency of the butterfat over the A.I.V. values.

Rats fed on mineralized milk produced by cows fed A.I.V. alfalfa grew more rapidly than rats fed mineralized winter milk. There was no appreciable difference in the growth of rats fed milk produced from A.I.V. silage, green alfalfa, or pasture.

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A COMPARATIVE STUDY OF METHODS OF DETERMINING THE MOISTURE CONTENT OF CHEDDAR CHEESE

I. THE MODIFIED MOJONNIER AND OLIVE OIL METHODS*

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INTRODUCTION

The chief disadvantage of the majority of methods which have been developed for the determination of moisture in cheddar cheese is the time required for operation. For example, 24 hours of heating at 100° C. is recommended for the drying oven method when a 2–3 gram sample of cheese is used (1), whereas the steam pressure oven method (2) and the official method as outlined by the Association of Official Agricultural Chemists (3) require about 2.5 and 4.5 hours respectively. The Mojonnier moisture test for cheese (4) requires less time than these other methods but the equipment is more elaborate and expensive than can be afforded by many cheese factories.

For years, little success was obtained in the development of a rapid, simple, open-flame method for the determination of moisture in cheese similar to the method ordinarily used for butter. Troy (5) early concluded such a procedure gave unsatisfactory results because, first, the cheese when heated swelled and sputtered badly, which brought about loss of the sample, and secondly, constituents other than moisture were apt to be driven off due to the high temperature of heat and the fact that the cheese stuck to the bottom of the pan. The result of these conclusions was the development of a fairly rapid method by this investigator (4) (5). This method consists briefly in the heating of a 5 gram sample in a double-walled copper cup at a temperature of about 140–145° C. for 50 minutes. The space between the double walls of the cup is filled with oil and the heating is accomplished by means of an alcohol or gas flame. The loss of weight indicates the moisture of the sample.

During 1933, the author's attention was called to the fact that at least one cheese plant in Michigan was determining the moisture content of cheese by use of an open flame method in which olive oil was placed in the

pan with the cheese to prevent burning and sputtering. Preliminary work on a study of this moisture test was carried out shortly thereafter to determine the possible merits of the procedure. Later, in 1935, Dittrich (6) recommended a similar rapid moisture test for process cheese, and with the exceptions of using a 5-gram sample, and placing 10 cc. of olive oil in the moisture dish with the sample, the procedure was the same as for the open flame method for butter.

Oil methods similar to the above have been utilized by other workers, but no published data concerning them are available. Sammis (7) states that such a test has been used in warehouses and in schools for cheese-makers throughout Wisconsin, and recommends the use of an aluminum cup 2 inches in diameter and 3 inches in height for the moisture determination, which he believes is deep enough to prevent spattering if any occurs. Olive oil was found to be satisfactory for this test and to lose no weight when heated alone over a small flame. Approximately 30 minutes was found to be required for the test, and results agreed well with the oven tests. A similar moisture test is reported by Greer (8) with cottonseed or boiled linseed oil being used in place of the olive oil. The heating of the sample was carried out on a hot plate, 30 to 45 minutes being required for the heating period. The results were found to be within one per cent of those obtained by using the regular oven moisture test.

Since no published investigational work is available regarding the practicability and accuracy of an open flame test involving the use of olive oil and of factors which may influence its accuracy, a study of such a method was made. The results secured by analyzing cheddar cheese for moisture by this method were compared to results secured on the same samples by a modified Mojonnier method.

EXPERIMENTAL

The cheese sample which was to be analyzed was trimmed free of the rind and of dried surfaces and then was finely chopped and placed in a glass jar with a tightly fitting metal screw cap. The sample was kept in a refrigerator, being brought out only for a period sufficiently long to permit weighing of the cheese for the moisture determination.

The Mojonnier method, with which the olive oil results were compared, was carried out according to recommendations (4) with one minor modification. This modification was made after preliminary trials showed the results to not differ appreciably from those secured by the use of the regular Mojonnier procedure. The regular Mojonnier procedure requires a glass rod to be used to break up the particles of cheese prior to the drying of the cheese on the hot plate. In this study no glass rod was used, but instead approximately 3 cc. of water was added to the sample. The sample was then heated slowly on the hot plate with continuous, gentle shaking until the

particles were melted and dispersed. From this point on, the sample was treated according to the regular procedure.

Since no information was available as to the most desirable procedure for the olive oil method, the procedure for this method was varied to some extent at first to determine the amount of oil and the size of sample which would give the most satisfactory results. With these exceptions, the olive oil test was conducted as follows:

The desired amount of high grade olive oil was measured into an aluminum dish, the dishes used being the same as those used for fat determination with the Mojonnier apparatus, *i e* , about 5 cm. in height and about 8 cm. in diameter. The oil was heated in the dish over a small gas flame until it began to fume slightly to make certain it was free from moisture. The olive oil used was found to contain little or no moisture. The pan and dried oil were cooled and then balanced on the right hand platform of a Torsion butter-moisture scale. The desired amount of finely chopped cheese was weighed carefully and allowed to become covered with the oil by gently tilting the pan. The cheese was dried by heating the pan and its contents over a low gas flame. During the heating the pan was gently shaken to keep the cheese from sticking to the bottom of the dish and to permit more efficient evolution of moisture. The heating and shaking was carried on until bubbling ceased. The pan and its contents were cooled and weighed, and the reading secured on the balance beam was corrected to the basis of a 10 gram sample.

Variations in Method: Variations in the size sample and in the amount of olive oil to use were studied at first to determine the procedure which would give the greatest constancy in results. Three different variations were tried. One procedure, Method A, consisted of using a 5 gram sample and 20 cc. of olive oil; the second, Method B, consisted of using a 5 gram sample and 10 cc. of olive oil and the third, Method C, consisted of 2.5 grams of cheese and 10 cc. of oil. Other than these differences, the procedures were the same. No particular effort was made to weigh exactly the same size sample each time. However, care was used so that the weight of the sample did not differ more than 0.25 gram from the size desired.

A total of 20 trials were carried out in which comparisons were made between these three variations in the procedure. The results are shown in Table 1. These data indicate that on the basis of averages, Method A give closer duplicate checks than the other methods. The average difference between duplicate determinations for Method A was 0.14 ± .01 per cent; for Method B, 0.23 ± .03 per cent; and for Method C, 0.55 ± .07 per cent. When the procedure for Method A was followed, 17 or 85 per cent of the trials gave differences between duplicates not exceeding 0.20 per cent. In comparison, only 9, or 43 per cent of the 21 trials using Method B, and 5 or 30 per cent of the 15 trials using Method C fell within this class.

TABLE 1

*The influence of variations in the olive oil procedure of the uniformity of duplicate determinations**

SAMPLE NO.	DIFFERENCE BETWEEN DUPLICATE TESTS		
	Method A	Method B	Method C
1 ..	0.00	0.06	0.20
2	0.20	0.40	0.91
3	0.05	0.34	0.64
4	0.01	0.36	0.60
5	0.13	0.21	0.22
6	0.11	0.27	0.11
7 .	0.15	0.21	0.70
8 .	0.28	0.04	
9	0.18	0.16	1.41
10 ...	0.19	0.11	
11 .	0.04	0.27	0.31
12 .	0.16	0.21	
13 .	0.06	0.04	
14 .	0.21	0.76	0.02
15 .	0.07	0.29	1.36
16	0.16	0.42	0.71
17	0.16	0.06	0.20
18	0.20	0.24	0.40
19	0.15	0.11	0.47
20	0.12	0.03	0.13
21 ..	0.32	0.16	1.10
Average difference between duplicates	0.14 ± .01	0.23 ± .03	0.56 ± .07

* Procedure for all methods identical with exceptions that Method A used 20 cc. of oil and 5 grams of the sample; Method B, 10 cc. of oil and a 5 gram sample; and Method C, 10 cc. of oil and a 2.5 gram sample.

These trials point out the value of using sufficient oil to at least fairly well cover the cheese sample. The use of too small a volume of oil permitted excess sticking and spattering of the sample and cause appreciable errors in the moisture determinations. There was no apparent need, however, for excessively large amounts of the oil. The amount of oil to use would be governed largely by the size of the sample and the diameter of the moisture dish. Smaller amounts of oil could without question be used satisfactorily in moisture dishes of small diameters. However, in the trials of this experiment, because of the greater constancy of the results secured when Method A was used, this procedure was selected as the one to be subjected to further study.

Difficulties Encountered. Several difficulties were experienced in securing proper moisture analysis of cheese samples by any of the above olive oil methods. In most trials, the cheese stuck more or less badly to the bottom

of the moisture dish during heating. This sticking occurred regardless of the amount of olive oil, although it was more noticeable in methods B and C. The dish appeared to be one source of trouble since the use of new pans largely eliminated the sticking of the cheese in Method A and lessened it to a marked degree in Methods B and C. In addition to the sticking of the cheese during the heating process, the cheese also lumped or clumped into one mass, and it seemed practically impossible to prevent such lumping. This lumping in itself would appear to prevent complete drying of the cheese.

Another major difficulty encountered with the olive oil tests was that of spattering. This spattering was noted only when certain samples were heated, and once it occurred it was not easily remedied. The spattering was noticeable immediately at the start of the heating period and was accompanied by considerable crackling and snapping. The usual result was the loss of some of the material from the dish, which, consequently, resulted in errors. As a general rule, if spattering occurred, it could not be prevented by more careful or slower heating. Because of large errors which naturally resulted from the heating of samples showing the tendency to spatter, it was decided to eliminate all data relative to such samples from consideration until some modification was devised to prevent the occurrence of the difficulty. Therefore, the 31 trials of the olive oil test reported in Tables 2 and 3 are the results obtained from non-spattering samples.

Differences between Duplicates: A measure of the constancy or consistency of any method of analysis may be shown by the closeness of the checks between duplicate determinations carried out by this method. The variations between duplicate determinations by the modified Mojonnier and the olive oil method are given in Table 2. The averages show little differences between the two methods with the Mojonnier method averaging 0.30 ± .03 per cent between duplicates and the olive oil method averaging 0.26 ± .03 per cent. The olive oil method's average difference is somewhat higher than shown for Method A in Table 1, but this is at least partially due to abnormally large differences between the duplicates determinations secured on samples 18 and 24. Fourteen, or 45 per cent of the Mojonnier determinations, varied 0.2 per cent or less between duplicates, whereas 24 or approximately 77 per cent varied less than 0.5 per cent. Of the 28 samples analyzed by the olive oil method, 18 or approximately 64 per cent varied 0.2 per cent or less, whereas 26 or about 93 per cent showed variations no greater than 0.5 per cent.

Comparison of Modified Mojonnier and Olive Oil Methods: The results of the analysis of thirty-one samples of cheese by the modified Mojonnier and olive oil methods are given in Table 2. The results show close agreements between the two methods, with the olive oil method giving results averaging about 0.3 per cent higher than those secured by the Mojonnier

TABLE 2

The differences between duplicate determinations of the moisture content of cheese by the modified Mojonnier and the olive oil methods

SAMPLE NO.	DIFFERENCE BETWEEN DUPLICATES PER CENT	
	Modified mojonnier	Olive oil
1	0.64	0.00
2	0.09	0.20
3	0.20	0.05
4	0.24	0.01
5	0.11	0.13
6	0.15	0.11
7	0.63	0.15
8	0.33	0.27
9	0.64	0.21
10	0.22	0.12
11	0.58	0.18
12	0.28	0.18
13	0.50	0.04
14	0.10	0.15
15	0.52	0.06
16	0.04	0.10
17	0.91	0.42
18	0.03	1.47
19	0.37	0.21
20	0.54	0.07
21	0.24	0.16
22	0.44	0.16
23	0.24	0.41
24	0.01	1.21
25	0.08	0.39
26	0.39	0.12
27	0.02	0.32
28	0.15	0.24
29	0.14	
30	0.16	
31	0.19	
Avg.	0.30 ± .03	0.26 ± .03

procedure. The average of the differences between individual determinations by the two methods shows the olive oil method to give values differing from the Mojonnier results by $0.38 \pm .04$ per cent. Twenty-six of the thirty-one determinations gave higher results by the oil method.

Modification of the Olive Oil Method. As previously stated, considerable difficulty was experienced during the heating of certain samples when following the olive oil procedure, because of the samples spattering and throwing a portion of the material from the dish, and also because of the samples sticking to the bottom of the pan.

The results appearing in the preceding tables show great possibilities for

the olive oil method, providing no spattering or sticking occurs. In view of this, efforts were made to modify the method to eliminate at least a portion of the difficulties encountered when the regular procedure is followed

The possibilities of using sodium chloride with the olive oil was suggested and trials were conducted to determine its influence   About one gram of the salt was added to the olive oil and the mixture dried over the flame as before. Variations in the amount of salt apparently did not influence the results. The samples analyzed were those which, in many cases, did not lend themselves to analysis by the regular olive oil method   The

TABLE 3

The moisture content of Cheddar cheese when determined by the modified Mojonnier and olive oil methods

SAMPLE NO	MODIFIED MOJONNIER METHOD	OLIVE OIL METHOD (A)	
	Moisture per cent	Moisture per cent	Difference from Mojonnier per cent
1	36.54	36.60	+ 0.04
2	34.86	34.90	+ 0.04
3	33.82	34.31	+ 0.49
4	33.35	33.85	+ 0.50
5	33.82	34.14	+ 0.32
6	33.66	33.75	+ 0.09
7	33.96	34.03	+ 0.07
8	35.75	35.72	− 0.03
9	30.70	29.99	− 0.71
10	33.52	33.87	+ 0.35
11	30.48	30.29	− 0.19
12	31.55	31.73	+ 0.18
13	43.82	44.02	+ 0.20
14	44.12	44.05	− 0.07
15	43.34	43.50	+ 0.16
16	42.49	42.76	+ 0.27
17	41.44	41.96	+ 0.52
18	43.36	43.77	+ 0.41
19	37.95	38.71	+ 0.76
20	35.92	36.43	+ 0.51
21	36.35	36.75	+ 0.40
22	32.94	32.78	− 0.16
23	33.04	33.54	+ 0.50
24	33.37	34.02	+ 0.65
25	37.12	37.28	+ 0.16
26	39.90	40.28	+ 0.38
27	34.11	34.76	+ 0.65
28	36.04	36.46	+ 0.42
29	38.60	40.24	+ 1.64
30	34.68	35.23	+ 0.55
31	39.50	39.75	+ 0.25
Avg.	36.45 ± .48	36.75 ± .49	0.38 ± .04

procedure, with the exception of adding the salt, was the same as followed previously. A marked improvement in the ease of drying the samples was immediately observed. In the first place, the salt prevented spattering of the sample in practically all cases. The only spattering which was observed occurred when 10 cc. of oil were used instead of 20 cc. Secondly, the salt prevented the cheese from sticking to the bottom of the pan, irrespective of the condition of the pan itself. Thirdly, the salt prevented the cheese from gathering in one large lump during the heating, as it had in most cases in which olive oil alone was used. The cheese particles remained in small balls in the olive oil-salt mixture throughout the drying period, and thus, from all appearances, were in condition to facilitate more rapid and more complete drying.

Variations in Method. Since the use of salt corrected the major defects of the olive oil method, it appeared desirable to determine the accuracy of a modified procedure (designated as modified oil method) in which salt was used. The first step taken was to determine again the comparative constancy of the three different procedures heretofore listed as Methods A, B, and C, which were in all cases modified by the addition of about a gram of salt. As before, Method A consisted of using 20 cc. of oil with 5 grams of cheese; Method B, 10 cc. of oil with 5 grams of cheese; and Method C, 10 cc. of oil with 2.5 grams of cheese. The comparison of the results of these methods is given in Table 4.

The results in this table again' show a somewhat greater accuracy of Method A over the other olive oil methods on the basis of variation between duplicate samples, the average variation for this method being $0.20 \pm .03$ per cent, as compared to $0.27 \pm .03$ per cent for Method B, and $0.47 \pm .11$ per cent for Method C.

A closer study of the results in this table show that 12, or 63.2 per cent of the variations between duplicates in modified olive oil Method A were not greater than 0.2 per cent, whereas, on the same basis, the values for olive oil Method B were 9 or 52.9 per cent; and for Method C, 6 or 42.9 per cent. The greatest variation in olive oil Method A was less than 0.6 per cent, whereas for Methods B and C the variations were larger than 0.8 per cent. In no case was spattering observed in following the procedure as outlined for Method A of the modified oil test, although it occurred to such an extent on Samples 1 and 16 when Method B was used as to render the moisture determination by this method impractical.

Table 4 also shows that 9 of the 20 samples analyzed in these trials did not lend themselves to moisture analysis by the regular olive oil procedure, whereas they were analyzed without difficulty by Method A of the modified procedure. This emphasizes the value of the salt modification if the olive oil method is to be generally adaptable.

Comparison of Modified Oil and Mojonnier Methods: The average values

TABLE 4

The influence of variations in the modified olive oil procedure on the uniformity of duplicate determinations

SAMPLE NO.	DIFFERENCE BETWEEN DUPLICATES PER CENT		
	Method A	Method B	Method C
1*	0.57	**	2.64
2		0.82	1.43
3*	0.60		
4	0.26	0.10	0.55
5	0.32	0.74	0.24
6	0.17	0.13	
7	0.14	0.16	0.05
8	0.21	0.30	0.30
9*	0.07	0.32	0.07
10*	0.16	0.10	
11	0.19	0.12	
12	0.10	0.28	0.21
13	0.24	0.17	0.13
14*	0.13	0.21	0.02
15	0.10	0.39	
16	0.07	**	0.28
17	0.02	0.30	0.12
18*	0.03	0.20	0.20
19*	0.05	0.15	0.14
20*	0.46	0.07	0.61
Average difference	0.20 ± .03	0.27 ± .03	0.47 ± .12

* Sample spattered badly when heated in olive oil which did not contain added salt. Such samples did not permit accurate moisture determinations by the regular olive oil method.

** Sample spattered while being heated and some material was lost from the dish.

of 20 moisture determinations made by the modified oil method (A), and by the modified Mojonnier method are given in Table 5. The average moisture content of the samples by the Mojonnier procedure was 36.06 ± .52 per cent and by the modified olive oil method was 36.61 ± .53 per cent, a difference of 0.55 per cent. Nineteen of the twenty trials gave higher values by the modified olive oil method with the average of all differences being 0.56 ± .05 per cent.

DISCUSSION AND SUMMARY

This study was carried out to determine the desirability of using a so-called olive oil test as a means of determining the moisture content of Cheddar cheese, and to modify it if necessary so that the results by this method would be accurate enough for all practical purposes.

Preliminary results, secured by using variations in the olive oil procedure, showed more constant values could be obtained if the sample weighed approximately 5 grams and approximately 20 cc. of olive oil were used. Wider variations between duplicate determinations were obtained if

TABLE 5

The moisture content of Cheddar cheese when determined by the modified Mojonnier and modified olive oil methods

SAMPLE NO.	MODIFIED MOJONNIER METHOD	MODIFIED OLIVE OIL METHOD (A)	
	Moisture per cent	Moisture per cent	Difference from Mojonnier per cent
1	37.61	38.07	+ 0.46
2	35.92	36.76	+ 0.84
3	36.35	37.17	+ 0.82
4	32.94	33.10	+ 0.16
5	33.04	33.12	+ 0.08
6	33.37	34.48	+ 1.11
7	37.12	37.45	+ 0.33
8	38.26	38.89	+ 0.63
9	39.90	40.84	+ 0.94
10	40.29	40.60	+ 0.31
11	34.11	34.83	+ 0.72
12	34.54	34.85	+ 0.31
13	36.04	36.39	+ 0.35
14	38.60	39.89	+ 1.29
15	34.68	34.84	+ 0.16
16	39.21	39.61	+ 0.40
17	41.06	41.91	+ 0.85
18	39.50	39.77	+ 0.27
19	32.64	32.55	− 0.09
20	26.08	27.07	+ 0.99
Avg.	36.06 ± .52	36.61 ± .53	0.56 ± .05

10 cc. of oil were used with either a 5 or a 2.5 gram sample of cheese. This was due probably to the fact that insufficient oil was used to completely cover the cheese during the heating.

Thirty-one non-spattering samples of Cheddar cheese were analyzed for moisture by the olive oil method and by the modified Mojonnier method, with the oil method giving results averaging approximately 0.3 per cent higher than those secured by the Mojonnier procedure.

Many samples of cheese, however, spattered too badly upon healting in the olive oil to permit accurate moisture determinations. In fact, approximately 30 to 40 per cent of the samples encountered possessed this spattering tendency under the conditions of this experiment. In addition, practically all of the cheese samples, during heating, lumped together and stuck to the bottom of the pan. When a small amount of sodium chloride, approximately one gram, was added to the oil, the cheese particles did not clump together or stick to the bottom of the pan, nor did the cheese samples encountered in this study spatter upon heating.

The oil moisture test, modified by the use of the salt, gave results averaging approximately 0.5 per cent higher than those secured by the Mojonnier procedure. These higher values may have been due to the fact that the

particles of cheese did not clump or stick during the heating, thus permitting more efficient drying, and secondly to the dehydrating action of the salt itself. That the action of the salt was not merely physical was proved by the substitution of dry sand. The sand did not prevent sticking or spattering of the cheese.

It might be concluded, therefore, that in regard to its general applicability the modified olive oil test appears to be the most logical choice since it does not appear to be generally affected by samples with spattering characteristics or by the condition or type of moisture pans. Recognition should be given to the fact that the results by this method are likely to be slightly high in comparison to those secured by the regular olive oil and Mojonnier methods, although they appear accurate enough for all practical purposes.

One of the chief advantages of the open flame oil method is its rapidity of operation. A moisture determination by this procedure can be completed in approximately 20 minutes, with only 5–7 minutes actually being required for the heating period.

The results of this study dealing with the olive oil methods present possibilities for further investigational work. First, there is need for a comparison of results secured by the modified method with those obtained by a recognized accurate method since the Mojonnier method for cheese has not been officially adopted as a reliable standard for comparison with other procedure. In addition, there is a need for knowledge as to other oils which may be substituted for the olive oil, and also for information as to other materials which may be used to supplant the salt in the modified procedure.

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THE ELECTROKINETIC POTENTIAL OF MILK FAT

III. RELATION TO THE FAT GLOBULE "MEMBRANE"[1]

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The electrokinetic potential in any system is determined by the conditions present at the interface. This has been demonstrated by Abramson (1) who shows that quartz particles suspended in a liquid exhibit certain electrokinetic properties but when the surface of the quartz is covered with an adsorbed layer of a material such as gelatin the particles take the properties of the adsorbed layer. This fact indicates that studies of electrokinetic potentials might well be expected to yield information concerning the nature of the interface between the fat surface and the milk plasma.

HISTORICAL

The nature and distribution of the materials adsorbed on fat globules in milk have been subjects of investigation for many years. Ascherson (2) in 1840 suggested that a protein material formed a "skin" around the globules which he called "Haptogen Membrane." Storch (3) believed that the globules were surrounded by a mucoid substance which he called a "Slimmen-membran." Abderhalden and Völtz (4) analyzed the fat globule membrane material and secured variable results. They came to the conclusion that it contained a mixture of proteins. Titus, Sommer, and Hart (5) obtained membrane material by washing cream and found it to compare in composition and reactions with casein. Palmer and Samuelsson (6) called attention to the fact that the membrane contained phospholipids as well as proteins. Since then Palmer and his associates have published a series of papers (7, 8, 9, 10) covering researches on the membrane material isolated from washed cream and its relation to churning. It is generally accepted that the material present at the fat-globule/milk plasma interface is a mixture of proteins and phospholipids.

EXPERIMENTAL

Some of the results previously reported (11, 12) suggested the possibility of obtaining information concerning the composition of the fat globule membrane by altering the membrane and studying the effects of the alteratoins by means of electrophoretic measurements. Two general methods were used

to alter the membrane; progressive removal of the membrane from the fat globule surface by centrifugal separation of milk into creams of varying fat content or by washing cream; and by reconstructing a membrane by the adsorption of known milk constituents on the surface of the fat.

Separation Studies

Creams ranging from twenty to eighty per cent fat were obtained by separation of raw milk   Electrophoretic measurements, lipoid phosphorus and nitrogen determination were made on the different creams.   The electrophoretic measurements were made according to the procedure previously described (11).   Lipoid phosphorus determinations were made by the method adapted by Smith (13).   Nitrogen was determined by the Kjeldahl method.
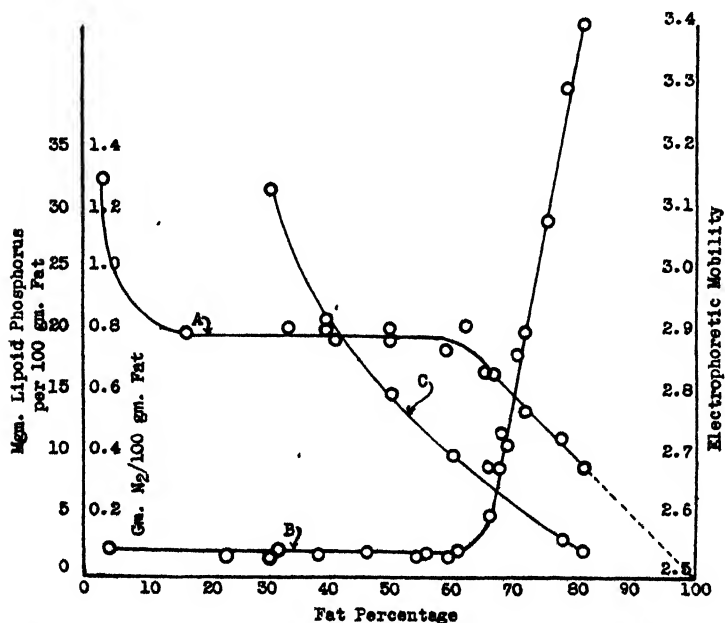
Legend: Curve A—Lipoid Phosphorus; Curve B—Electrophoretic Mobility;
Curve C—Nitrogen/100 gm. Fat.

FIG. 1. THE RELATION OF FAT PERCENTAGE TO ELECTROPHORETIC MOBILITY, LIPOID
PHOSPHORUS, AND NITROGEN CONTENT OF CREAM.

The results are shown in Figure 1.   The lipoid phosphorus values coincide with those found by Perlman (14) in a study covering the same fat percentage range.

To study the readsorption of milk constituents, a series of samples were prepared for an electrophoretic study in which skim milk from each sample was added to cream diluted so that each sample contained the same concen-

tration of milk solids-not-fat. The electrophoretic mobilities of the fat globules in creams of varying fat contents before and after readsorption of milk constituents is shown in Table 1.

TABLE 1

The effect of separation and readsorption of milk plasma components on electrophoretic mobility

FAT PERCENTAGE	MOBILITY µ/SEC/V/CM.	
	Before adding skim milk	After adding skim milk
3.7	2.56	
17.5	2.58	2.59
23.0	2.57	2.58
25.0	2.55	2.55
29.0	2.57	2.57
31.0	2.58	2.55
37.0	2.57	2.57
46.0	2.56	2.55
52.5	2.57	2.56
54.0	2.58	2.58
56.7	2.57	2.55
59.4	2.57	2.57
60.0	2.57	2.55
64.0	2.61	2.56
66.5	2.70	2.57
68.5	2.72	2.55
69.3	2.79	2.55
72.0	2.87	2.54
75.0	3.04	2.58
79.0	3.27	2.56
81.0	3.35	2.55

Washed Cream Studies

Cream was washed by diluting with three volumes of distilled water and reseparating after each dilution by means of a Sharples supercentrifuge. This procedure was repeated seven times. Samples were taken after each washing for electrophoretic, lipoid phosphorus, and nitrogen determinations. The values obtained are shown in Figure 2. Similar results were obtained by centrifuging in an International SB Centrifuge using glass tubes showing that the mechanical action of the centrifuge was not important in removing the membrane from the fat globules.

Synthetic Milk Studies

It seemed desirable to study the adsorption of known milk constituents on the surface of milk fat. To do this it was necessary to prepare synthetic milks. Solutions of milk salts, lactose, and a casein sol were prepared according to the method of Clark (15). Butter oil was prepared by centri-

fuging and filtering unsalted butter until it was phosphorus-free.   Milk
phospholipids were prepared by extracting washed cream buttermilk with
ethyl alcohol and ethyl ether and precipitating the phospholipids with ace-
tone.   The fat-free phospholipid had a phosphorus content of 3.87 per cent,
contained 1.73 per cent nitrogen and its isoelectric point was pH 2.0.   The
phosphorus and nitrogen contents correspond to those of a lecithin-like com-
pound with a molecular weight of approximately 800.

Pure butter oil was emulsified in each of the following three media to
result in a fat content of 0.6 per cent: (1) recently boiled distilled water,
(2) a sol containing 3 per cent casein, and (3) a sol containing 0.5 per cent
phospholipids.   The isoelectric points in each of the three media were deter-
mined in a M/15 acetate buffer.   The fat globules were isoelectric at pH 3.3
in distilled water, at pH 4.6 in the casein sol, and at pH 2.0 in the phos-
pholipid sol.   In the casein and phospholipid sols the isoelectric points corre-
spond to the isoelectric points of the stabilizing material, but in neither case
does the isoelectric point correspond to that of normal milk fat at pH 4.3.
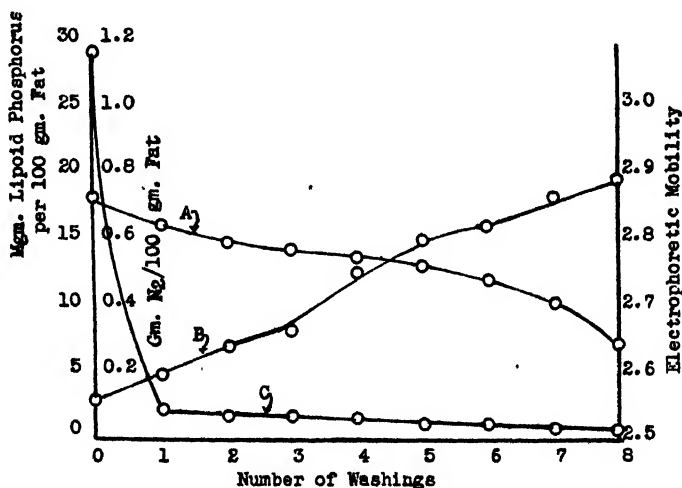
Legend: Curve A—Lipoid Phosphorus; Curve B—Electrophoretic Mobility;
Curve C—Nitrogen/100 gm. Fat.

FIG. 2. THE EFFECT OF WASHING CREAM UPON THE ELECTROPHORETIC MOBILITY, LIPOID
PHOSPHORUS, AND NITROGEN CONTENT.

The addition of milk salts, lactose solution, and phospholipid sol to the
dispersion of butter oil in the casein sol did not change the isoelectric point
from pH 4.6.   However, the addition of the casein sol, milk salts, and lactose
solution to the dispersion of butter oil in the phospholipid sol shifted the iso-
electric point to pH 4.3, the isoelectric point of the fat globules in normal
milk.   The results are shown in Figure 3.
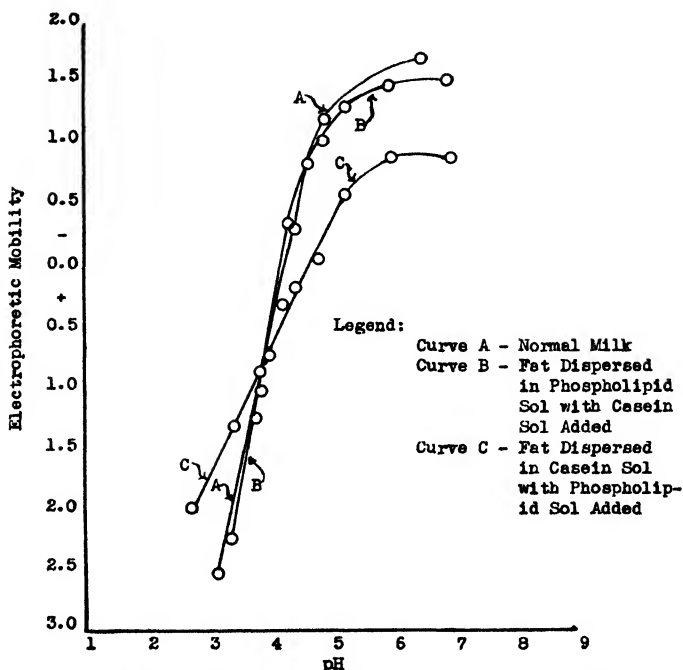
FIG. 3. THE pH MOBILITY CURVES OF NORMAL AND SYNTHETIC MILKS.

DISCUSSION

The data in Figure 1 show that the electrophoretic mobilities and lipoid phosphorus values per unit of fat in creams containing from 17 per cent milk fat to 60–65 per cent milk fat were constant.   Above this fat concentration the mobilities increase with increasing fat content, and the amount of lipoid phosphorus per unit of fat decreases.   The amount of nitrogen per unit of fat decreases practically uniformly as the fat concentration increases from 17 per cent to 81 per cent.   The point of the sharp break in the lipoid phosphorus curve at 60–65 per cent fat concentration has been suggested by Perlman (14) as the point of phase reversal in the emulsion system. No evidence of phase reversal is detectable microscopically.   It seems to the authors that this·point of the sharp break (Figure 1) is the point at which some of the tightly held phospholipid material in the fat globule membrane must be removed if one is to secure a cream with a higher fat content than 60–65 per cent.   Below this fat concentration separation results only in removing part of the free skim milk portion of the milk, but it appears to be necessary to remove some of the membrane material to secure cream of greater fat content.

Table 1 shows that whatever materials are removed from the surface of

the fat globules by separation may be readsorbed. It is apparent that this may take place when the entire membrane is not removed since some of the membrane remains on the surface of the globules even in 80 per cent cream.

The washed cream studies reveal certain facts as shown in Figure 2. Most of the protein of the milk plasma is removed by the first washing. The removal of phospholipids and of protein after the first washing is a gradual process through eight washings and there is no apparent place where there is any change in the ease of removal of either. There was considerable "oiling off" after eight washings.

The synthetic milk studies indicate that it is possible to reconstruct milk exhibiting properties of normal milk. The position of the isoelectric points of the fat globules in the different systems studied suggests, when considered in conjunction with other data presented, that the membrane on the surface of the fat globules is a phospholipid-protein complex, in which the phospholipid is oriented toward the fat and the protein into the liquid phase. This arrangement is also in accord with current views in regard to molecular polarity and molecular orientation as presented by Harkins (16) and Langmuir (17).

The authors wish to call attention to the fact that casein was used in the adsorption studies solely because it was the only milk protein available in usable form and not because of any views they might have had regarding the nature of the protein normally present. They have presented no data concerning the protein that might be present in the membrane of normal milk.

SUMMARY AND CONCLUSIONS

The lipoid phosphorus content per unit of fat declines slightly in creams from 17 per cent fat to 60–65 per cent fat and above 65 per cent fat it decreases rapidly up to a fat content of 81 per cent.

The electrophoretic mobilities of the fat globules is constant up to a fat content of 65 per cent and above this they increase rapidly.

The nitrogen content decreases gradually with increasing fat content.

In washed cream most of the protein was lost in the first washing and there was a gradual decrease in protein content thereafter up to eight washings. The phospholipid content decreased gradually throughout the washings.

Synthetic milk, in which a casein layer is adsorbed on a phospolipid layer existing on the surface of fat globules, resembled normal milk in the position of the isoelectric point and the slope of the pH/mobility curve, suggesting the probability of a double layer membrane on the surface of the fat globules.

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POWER REQUIREMENTS FOR FREEZING ICE CREAM[1]

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INTRODUCTION

Some difficulty has been experienced in attempting to freeze and whip heavy, viscous ice cream mixes in a forty quart, direct expansion freezer, equipped with a 3 H.P. motor. Excessive heating of the motor, reduced dasher speed, and blown out fuses were frequently encountered, especially when an attempt was made to draw ice cream from the freezer at 24° F. or below.

In an effort to find a remedy for these difficulties, a larger motor was used on the freezer and the speed of the freezer dasher increased by means of a larger pulley. Other factors included studies relative to the effect of shutting off the refrigerant at various temperatures, varying the percentage and kind of stabilizer, and the use of egg yolk in the mixes upon the power requirements for the freezer and the quality of the ice cream.

REVIEW OF LITERATURE

Previous work dealing with power requirements for ice cream freezers has been confined largely to commercial plants, some of which were using methods no longer applicable to present day plant practices. It was reported by Turnbow (1) that the average power load for a forty quart freezer was 2.12 H.P. and the energy consumed per batch varied from 0.279 to 0.522 kilowatt hours. The variation in the power load throughout the freezing process, as reported by Reid (2), increased from 0.60 H.P. at the end of the first minute of freezing to 4.33 H.P. at the time the ice cream was drawn from the freezer. More recent data collected by DePew (3) indicate that the maximum power load was reached at the time the refrigrant was cut off, after which it declined. The amount of power required to manufacture a gallon of ice cream was calculated by Vetter (4) to be 0.319 kilowatt hours, about one-fifth of which was consumed by the freezer.

The need for more powerful motors and a higher dasher speed when freezing ice cream to below 24° F. was suggested by Olson (5) and Thomas (6). These investigators found that the use of low temperature refrigerants resulted in excessive vibration of the freezer. The vibration was attributed to inadequate speed of the scraping blades which allowed the mix to freeze in thick layers on the wall of the freezer. By increasing the dasher

speed from 169 to 220 revolutions per minute, Thomas (6) was able to overcome excessive vibrations, but the increased speed caused the motor to heat, indicating the need of a larger motor. Overheating was eliminated by replacing the 7.5 H.P. motor with a 10 H.P. variable speed motor. A reduction in dasher speed from 230 to 100 revolutions per minute after the refrigerant was shut off did not affect the rate of whipping and made it possible to eliminate the difficulty previously encountered in controlling overrun during the drawing period.

Reichert (7) found that increasing the speed of the scraping blades was more effective than increasing the speed of the beaters, in speeding up freezing and improving the quality of the ice cream. Other than the work of Olson, Thomas, and Reichert, most of the power studies on ice cream freezers have dealt with operating costs. Little attention has been given to the efficiency of the freezing process and its relation to improvement in the quality of ice cream.

EXPERIMENTAL PROCEDURE

This experiment may be divided into five parts. In Part I the refrigerant was cut off at 25.5° F., 24° F., and 22.5° F. Observations were made on the final temperature of the ice cream when drawn from the freezer, the time required to obtain 100 per cent overrun, the body and texture score of the ice cream, the dasher speed, the energy input to the motor, and the total power required for freezing. A forty quart, direct expansion freezer (Creamery Package) was used for freezing a standard 12 per cent fat ice cream mix. A kilowatt hour-meter was used to measure the total power consumed. A continuous record of the energy input to the motor was obtained by the use of a recording watt meter. At one minute intervals during the freezing process, the temperature of the mix and speed of the dasher were recorded; and at two minute intervals, overrun determinations were made. The temperature of the mix was obtained with a suitable thermometer graduated to 0.1 ° F. inserted through the peep hole of the freezer to a uniform depth in the mix. The dasher speed was read from a millivoltmeter actuated by an electric tachometer belted to the dasher shaft of the freezer. Overrun percentages were determind wtih a Mojonnier overrun tester. The quality of the finished ice cream was measured by scoring properly hardened pint samples which had been taken from the freezer when the overrun reached 85 per cent.

In Part II the procedure was the same except that the 22.5° F. temperature for cutting off the refrigerant was eliminated because in Part I it proved to be impracticable. In this trial, mixes containing no stabilizer were compared with those containing 0.25 and 0.35 per cent of a 250 Bloom strength gelatin and those containing 0.26 per cent of Dariloid.

In Part III the results obtained when operating the freezer with a 3 H.P.

motor were compared with those obtained with the same freezer powered by a 5 H.P. motor. The standard mix of Part I was used.

Part IV was similar to Part III except that 1.5 per cent egg yolk was added to the standard mix, and the dasher speed increased from 170 to 200 revolutions per minute.

Part V consisted of a comparison of different dasher speeds using a 5 H.P. motor to freeze both a standard mix and a mix containing 1.5 per cent egg yolk.

DISCUSSION OF RESULTS

Part I—Effect of Cutting Off the Refrigerant at Various Temperatures

Lowering the temperature at which the refrigerant was cut off reduced the dasher speed and the rate of whipping while it increased the energy input to the motor and the total power used in freezing. (Table 1 and Fig. 1.)

TABLE 1

Relation of temperature at which the refrigerant was cut off to the rate of freezing, the quality of the finished ice cream, and total power consumed

(3 H.P. motor, initial dasher speed approximately 170 R.P.M.)

TRIAL	NO. OF BATCHES	MIX USED	TEMPERATURE AT WHICH REFRIGERANT WAS SHUT OFF	DRAWING TEMPERATURE	TIME REQUIRED TO OBTAIN 100% OVERRUN	BODY AND TEXTURE SCORE OF FINISHED ICE CREAM	TOTAL POWER USED
			(°F)	(°F.)	(Min)		(K.W.H.)
A	3	Standard*	25.5	24.1	11.2	23.6	0.26
B	3	"	24.0	23.0	15.4	23.8	0.46
C	3	"	22.5	22.4	20.3	24.1	0.69

* per cent

No significant differences were observed in the quality of the ice cream when the refrigerant was cut off at 24° F. as compared with 25.5° F. A definite improvement in quality, however, resulted by cutting off the refrigerant at 22.5° F., but the use of such a low temperature with this particular equipment was not practicable nor economical due to the increased power consumption and prolonged freezing time. In all subsequent trials the temperature 22.5° F. was eliminated.

Part II—Effect of Varying the Kind and Amount of Stabilizer

The primary objectives of the second part of this study were first, to determine if the stabilizer in the mix could be reduced or eliminated by lowering the drawing temperature; and second, to compare the freezing
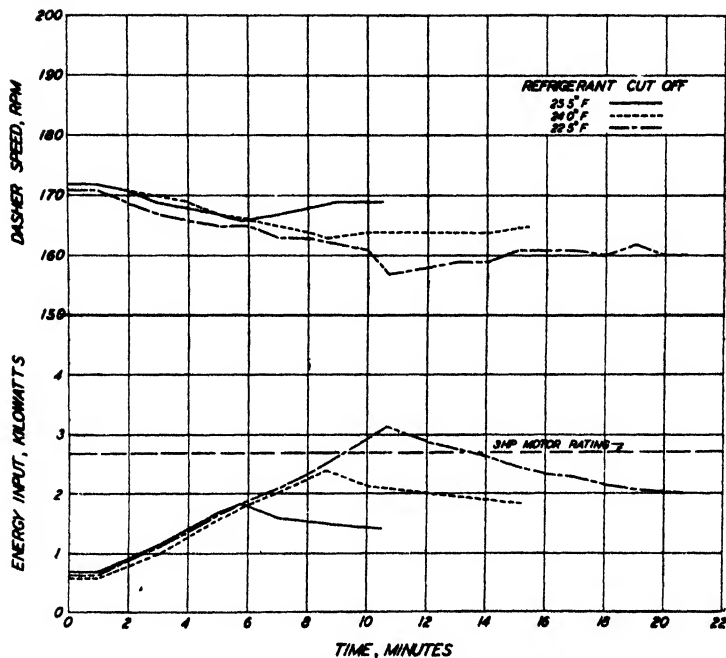
FIG. 1   RELATIONSHIP OF THE TEMPERATURE AT WHICH THE REFRIGERANT IS SHUT OFF TO DASHER SPEED AND ENERGY INPUT TO THE MOTOR.   (STANDARD MIX 3 H.P. MOTOR.)

properties of mixes stabilized with gelatin and Dariloid, when the refrigerant was cut off at two different temperatures.   Although the influence of stabilizers on the energy input and total power consumed was determined, this was of secondary importance.

The use of a stabilizing agent in the mix had a more significant effect on the quality of the ice cream than did a reduction in the drawing temperature within the limits observed (22.7–23.8° F., Table 2).   Although absence of stabilizer in the mix, or the use of a limited amount, slightly reduced the time and total power required to freeze, such practices can not be recommended because of their adverse effect on the quality of the ice cream.

Reduction in the drawing temperature, within the limits previously mentioned, had no significant influence on quality.   In two of the trials (Trials C and D, Table 2) the ice cream drawn at the higher temperature scored slightly higher than that drawn at the lower temperature.   These results emphasize the fact that many factors other than drawing temperature may influence the quality of ice cream.

As the temperature at which the refrigerant was cut off was lowered the time required to obtain 100 per cent overrun and the total power were increased (Table 2).   These results are in harmony with those obtained in

TABLE 2

Relation of the kind and percentage of stabilizer used to the rate of freezing, the quality
of the finished ice cream, and total power used when the refrigerant
was cut off at 25.5 and 24 deg. F. respectively

(3 H.P. motor initial dasher speed approximately 170 R.P.M.)

TRIAL	NO. OF BATCHES	MIX USED*	TEMPERA-TURE AT WHICH REFRIG-ERANT WAS SHUT OFF	DRAWING TEMPERA TURE	TIME RE-QUIRED TO OBTAIN 100% OVERRUN	BODY AND TEXTURE SCORE OF FINISHED ICE CREAM	TOTAL POWER USED
			(°F.)	(°F.)	(Min.)		(K.W.H)
A	3	No stabilizer	25.5	23.6	9.8	22.3	0.29
A₁	3	No stabilizer	24.0	22.8	12.7	22.3	0.55
B	2	0.25 per cent gel.	25.5	23.7	10.5	22.6	0.29
B₁	2	0.25 per cent gel.	24.0	22.7	13.5	22.6	0.50
C	3	0.35 per cent gel.	25.5	23.8	11.7	23.6	0.36
C₁	3	0.35 per cent gel.	24.0	23.2	15.8	23.3	0.63
D	3	0.26 per cent Dariloid	25.5	23.8	10.7	23.5	0.35
D₁	3	0.26 per cent Dariloid	24.0	23.1	15.0	23.3	0.60

* All mixed reported in this table had the same composition as the standard mix except for the stabilizer.

Part I. The increase in freezing time resulting from cutting off the refrigerant at 24° F. instead of 25.5° F. varied from 2.9 minutes per batch when no stabilizer was used to slightly over 4 minutes when standard amounts of either gelatin or Dariloid were used. It would appear that the time required to freeze is most adversely affected by the use of a lower drawing temperature when stabilizers are used in the mix.

When the refrigerant was cut off at 24° F. the total power used was from 71 to 90 per cent more than when the refrigerant was cut off at 25.5° F. The largest percentage increase in total power used occurred with the mix containing no stabilizer, and the smallest increase occurred with the mix stabilized with Dariloid.

The total power required to freeze comparable mixes was considerably higher in Part II than it was in Part I (C and C₁, Table 2 and Table 1). This difference amounted to 0.10 kilowatt hours when the refrigerant was cut off at 25.5° F. and 0.17 kilowatt hours when the refrigerant was cut off at 24° F. No satisfactory explanation has been found for these differences. The slight increase in time required to obtain 100 per cent overrun in Part II would be a contributing factor to the increase in total power but it probably does not account for all the difference. These data substantiate the results reported by Turnbow (1) in showing that the power requirements

may vary rather widely even with the same freezer operated under as nearly uniform conditions as possible.

Parts III and IV—Comparison of 3 and 5 H.P. Motors

Replacing the 3 H.P. motor with a 5 H.P. motor slightly reduced the time required to obtain 100 per cent overrun, and the total power used, when freezing a standard mix (Table 3). The ice cream was either equal

TABLE 3

Relationship of motor size to the rate of freezing, the quality of the finished ice cream and total power consumed

(Initial dasher speed approximately 170 R.P.M. in all trials)

TRIAL	NO. OF BATCHES	MIX USED	MOTOR SIZE	TEMPERATURE AT WHICH REFRIGERANT WAS SHUT OFF	DRAWING TEMPERATURE	TIME REQUIRED TO OBTAIN 100% OVERRUN	BODY AND TEXTURE SCORE OF FINISHED ICE CREAM	TOTAL POWER USED
			(H.P.)	(°F.)	(°F.)	(Min.)		(K. W. H.)
A	4	Standard*	3	25.5	23.8	11.7	23.6	0.36
B	3	"	5	25.5	24.0	11.4	23.5	0.33
C	4	"	3	24.0	23.2	15.7	23.6	0.65
D	3	"	5	24.0	23.1	15.1	24.0	0.60

* (12 per cent fat, 10 per cent serum solids, 15 per cent sugar, and 0.35 per cent gelatin).

to or superior in quality to that obtained when the 3 H.P. motor was employed.

In freezing a mix containing egg yolk, the 5 H.P. motor again proved superior. The freezing time and the total power were slightly reduced and the quality of the ice cream improved (Table 4).

TABLE 4

Relationship of motor size to the rate of freezing, the quality of the finished ice cream and total power consumed. Mixes contained 1.5 per cent frozen egg yolk

(Initial dasher speed approximately 200 R.P.M.)

TRIAL	NO. OF BATCHES	MIX USED	MOTOR SIZE	TEMPERATURE AT WHICH REFRIGERANT WAS SHUT OFF	DRAWING TEMPERATURE	TIME REQUIRED TO OBTAIN 100% OVERRUN	BODY AND TEXTURE SCORE OF FINISHED ICE CREAM	TOTAL POWER USED
			(H.P.)	(°F.)	(°F.)	(Min.)		(K.W. H.)
A	1	Egg mix*	3	25.5	24.1	9.3	23.8	0.38
B	3	" "	5	25.5	24.0	8.9	24.1	0.37
C	2	" "	3	24.0	22.7	10.6	23.6	0.58
D	3	" "	5	24.0	22.9	10.0	24.1	0.48

* Egg mix contained 1.5 per cent frozen egg yolk in addition to the constituents contained in the standard mix.

The differences observed in the quality of the ice cream as affected by

the size of motor were small, the maximum difference amounting to only 0.5 of a point in body and texture score. Although such small differences are of doubtful significance, at least the conclusion seems warranted that the use of a larger motor on the freezer will not adversely affect the quality of the ice cream.

It has been assumed that the use of a 5 H.P. motor would be effective in preventing a drop in dasher speed but the data only partially substantiate this assumption. (See Figs. 2 and 3.) There was little difference in the
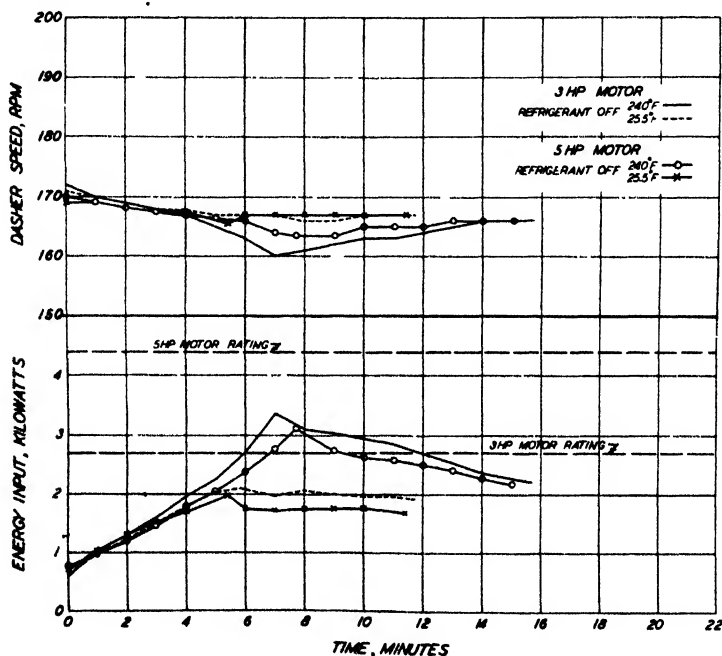
FIG. 2. EFFECT OF MOTOR SIZE ON THE ENERGY INPUT TO THE MOTOR AND DASHER SPEED. (STANDARD MIX USED IN ALL TRIALS.)

dasher speeds with either motor when the refrigerant was cut off at 25.5° F. At the lower drawing temperature, however, the drop in dasher speed was not as pronounced with the 5 H.P. motor as it was with the smaller motor (Figs. 2 and 3).

The energy input to the two motors was very similar in all cases when comparable conditions prevailed. (Figs. 2 and 3). The peak load in every case, however, was higher for the 3 H.P. than for the 5 H.P. motor. The maximum energy input for the standard mix was not as great as it was for the mix containing egg yolk. When the 3 H.P. motor was used and the refrigerant was shut off at 24° F., the maximum energy input to the motor amounted to 3.37 kilowatt hours with the standard mix as compared with

4.55 kilowatt hours with the egg mix. The latter figure represents a load in excess of the rating of the 5 H.P. motor. Similar differences were observed with the 5 H.P. motor. In no case, however, was the 5 H.P. motor overloaded. The need for a motor of ample power capacity when egg mixes are frozen is clearly indicated.
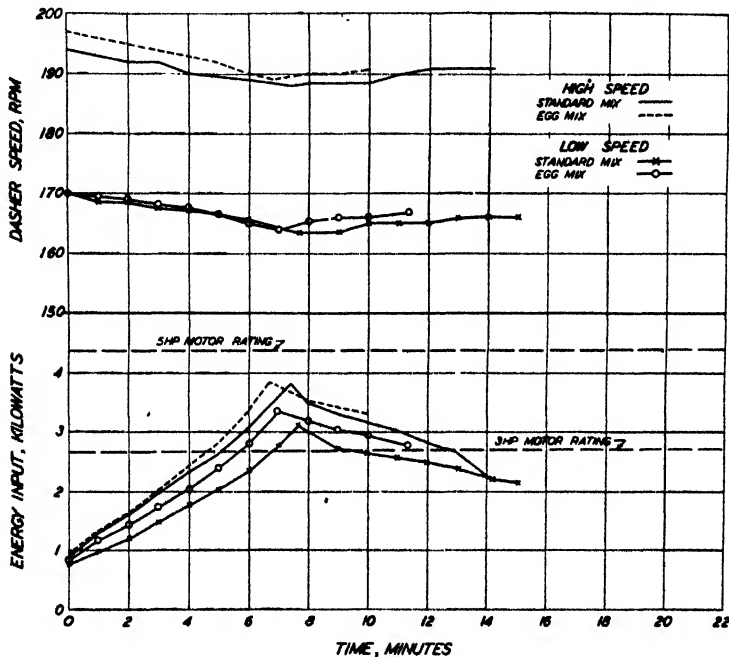
FIG. 3. EFFECT OF MOTOR SIZE ON THE ENERGY INPUT TO THE MOTOR AND DASHER SPEED WHEN AN EGG MIX WAS FROZEN AND THE REFRIGERANT SHUT OFF AT 24° F.

In the case of the mixes containing egg yolk the time required to obtain 100 per cent overrun was greatly shortened. The saving in time effected by the addition of eggs was most significant when the refrigerant was shut off at 24° F. A saving in time of 2.5 minutes per batch in favor of the mixes containing egg yolk irrespective of the motor used resulted when the cut off temperature was 25.5° F. When the refrigerant was cut off at 24° F., the saving in time effected by the use of egg yolk averaged 5.1 minutes per batch. (Tables 3 and 4.)

Although it was possible through the use of egg yolk in the mix to draw the ice cream from the freezer at a lower temperature and still obtain the desired overrun within a reasonable period of time, no beneficial effects from this procedure resulted as far as the quality of the finished ice cream was concerned.

Part V—Effect of Dasher Speed

Two different dasher speeds—170 R.P.M. in Part III and 200 R.P.M. in Part IV—were used in the comparisons made between the standard mix and the egg mix. This raised the question as to just how much influence a change in dasher speed would have on the rate of freezing, the quality of the finished ice cream, and the total power required.

TABLE 5

Relationship of dasher speed to the rate of freezing, the quality of the finished ice cream and total power consumed

(5 H.P. motor)

TRIAL	NO. OF BATCHES	MIX USED	DASHER SPEED	TEMPERA-TURE AT WHICH REFRIG-ERANT WAS SHUT OFF	DRAWING TEMPERA-TURE	TIME RE-QUIRED TO OBTAIN 100% OVERRUN	BODY AND TEXTURE SCORE OF FINISHED ICE CREAM	TOTAL POWER USED
				(°F.)	(°F.)	(Min.)		(K.W. H.)
A	3	Standard	low	24.0	23.1	15.1	24.0	0.60
B	3	Standard	high	24.0	23.2	14.1	24.2	0.65
C	3	Egg	low	24.0	22.7	11.4	24.3	0.50
D	3	Egg	high	24.0	22.9	10.0	24.1	0.48
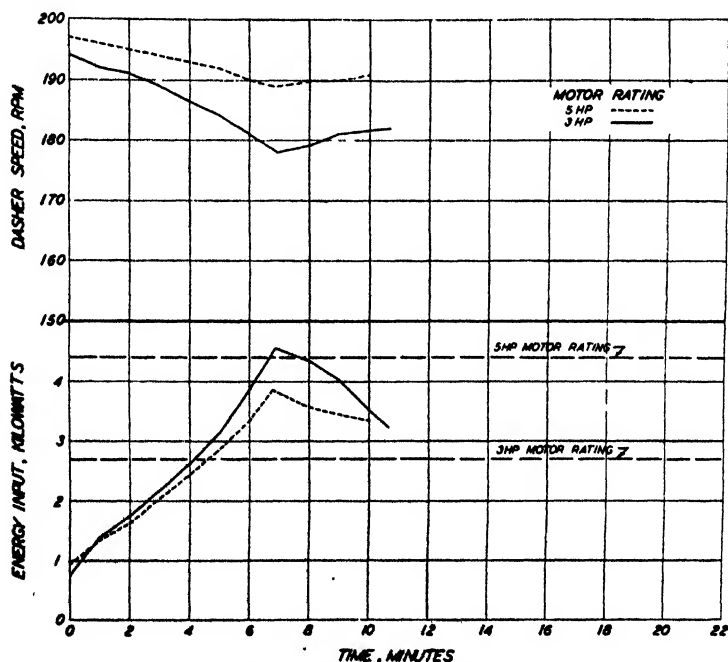
FIG. 4. RELATIONSHIP OF DASHER SPEED TO THE ENERGY INPUT TO THE MOTOR. (5 H.P. MOTOR. INITIAL DASHER SPEEDS APPROXIMATELY 170 AND 200 R.P.M.)

An increase in the speed of the dasher reduced the time required to obtain 100 per cent overrun and slightly increased the energy input to the motor but did not appreciably effect the total power required to freeze (Table 5 and Fig. 4).

The maximum drop in dasher speed amounted to 6.5 R.P.M. with the standard mix, irrespective of the initial speed. In the case of the mix containing egg yolk the drop in dasher speed amounted to 8 R.P.M. at the higher speed (200 R.P.M.) and 6 R.P.M. at the lower speed (170 R.P.M.). These data would seem to indicate that the decrease in dasher speed is fairly uniform irrespective of the initial speed of dasher.

No effect on the quality of the ice cream was observed as a result of changing the speed of the dasher.

SUMMARY AND CONCLUSIONS

In an attempt to improve the operating efficiency of the 40 quart, direct expansion freezer (Creamery Package) a total of 66 individual batches of ice cream have been made. The rate of freezing, the quality of the finished ice cream, and energy input to the motor were determined in relation to the temperature at which the refrigerant was cut off, the percentage and kind of stabilizer used, the size of motor, and the dasher speed. The results of this study may be summarized as follows:

1. Reduction in the temperature at which the refrigerant was cut off from 25.5 to 24 and 22.5° F. resulted in a decline in the dasher speed and rate of freezing but the energy input to the motor and the total power used in freezing were increased.

2. No significant differences were observed in the quality of ice cream when the refrigerant was cut off at 24° F. as compared with 25.5° F.

3. Although cutting off the refrigerant at 22.5° F. improved the quality of the ice cream, this temperature was neither practicable nor economical with the equipment used, due to prolonged freezing time and the increased power consumption.

4. The use of the proper amount of a suitable stabilizer had a more significant effect on the quality of the ice cream than did a reduction in the drawing temperature within the limits observed (22.7–23.8° F., Table 2). No significant differences were observed in the freezing properties, total power used, or in the quality of the ice cream stabilized with 0.35 per cent of a 250 Bloom strength gelatin as compared with 0.26 per cent Dariloid. The addition of stabilizer to a standard mix increased the freezing time and total power slightly.

5. A 5 H.P. motor improved the operating efficiency of the freezer and did not increase the total power consumed. The time required to reach 100 per cent overrun was slightly reduced and the quality of the ice cream was either equal to or superior to that produced with the 3 H.P. motor. In no

case was the 5 H.P. motor overloaded, whereas the 3 H.P. motor was seriously overloaded, particularly when a mix containing egg yolk was frozen and the refrigerant cut off at 24° F.

6. A marked difference in the energy input to the motor was observed between mixes containing egg yolk and the standard mix, irrespective of the size of motor used. When the 3 H.P. motor was used and the refrigerant was cut off at 24° F. the maximum energy input to the motor amounted to 3.37 kilowatt hours with the standard mix as compared with 4.55 kilowatt hours with the mix containing egg yolk. Similar differences were observed when the 5 H.P. motor was used.

7. The use of eggs in the mix shortened the time required to reach 100 per cent overrun. A saving of approximately 5.1 minutes per batch resulted when the refrigerant was cut off at 24° F., and a saving of 2.5 minutes per batch when the cut off temperature was 25.5° F.

8. Increasing the dasher speed from approximately 170 R.P.M. to 200 R.P.M. resulted in a slight saving in the time required to reach 100 per cent overrun. The energy input to the motor was increased but the total power was not affected appreciably.

9. Changing the speed of the dasher had no significant effect on the quality of the ice cream.

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A STUDY OF SOME FACTORS IN THE BUTTER CHURNING PROCESS

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The two most widely accepted explanations of the mechanisms of butter churning are those of Fischer and Hooker, usually referred to as the phase reversal theory (2), and the theory of Rahn (4), known as the foam substance theory. It is the opinion of some (7) that "the difference in the two theories lies mainly in the matter of point of view and of definitions." Nevertheless the proponents of the Fischer and Hooker theory regard the change from cream to butter as essentially due to a more or less complete liberation of butter fat, whereas those who favor the Rahn theory regard the change as due chiefly to an irreversible coagulation of protein. The liberation of free butter fat is not an essential feature of the conversion of cream into butter, according to the Rahn theory.

In the course of an investigation of the nature of dairy foam systems, results were obtained which are not readily explained in terms of either of the two theories mentioned, and therefore, a study of some of the physico-chemical factors bearing on the churning process was undertaken.

It has been conceded by investigators who have studied the churning process, that the establishment of a foam precedes butter formation. The different theories of butter churning recognize that the agglomeration or coalescence of fat globules takes place in the foam.

In any particular cream the agglomeration of the fat globules in a foam, and their possible coalescence will be influenced chiefly by the following physico-chemical factors:

a. Thickness and nature of the film adsorbed on the globule. The liberation of free fat requires a rupture of the adsorbed film; agglomeration of the globules does not.

b. Viscosity of the interglobular liquid. Rapid drainage of liquid from the foam structure is favored by low viscosity of the solution between the foam walls.

c. Electric charge on the globules. Lowering of the electric charges will diminish the repulsion of similarly charged fat globules, and will favor their coalescence.

It is evident that the physical properties of the fat-free portion of the film, forming the foam walls are important. A relatively strong film, which

resists distortion and destruction of the foam walls, will tend to retard globule agglomeration and coalescence.

The Thickness of Casein Films Adsorbed on Oil Globules

The stability of the fat globule in milk is chiefly due to an adsorbed protective film, the precise nature of which is still in doubt. Most investigators regard it as made up of casein and other proteins, together with phospholipids. King (3) supposes that the crystallization of fatty constituents with high melting-point may be a factor in producing a stable globule. Wiegner (8) has calculated that in normal milk approximately two per cent of the protein is adsorbed on the globules. This calculation is based on the assumption that the thickness of the stabilizing film is in the neighborhood of 6 m μ.

The complex nature of butter fat and of the aqueous solution of milk make it extremely difficult to determine experimentally the amount of substance in the adsorbed film. It seemed worth while to attempt an experimental verification of Wiegner's calculation in the case of a simplified system, consisting of a dispersion of a mineral oil in a solution of casein in water. Such a mineral oil contains no polar groups and cannot be considered strictly analogous to butter oil. Since an oil containing polar groups will presumably have a greater attraction for casein than a mineral oil, we may conclude that if we get adsorption with the latter, we should also find it with the former. The method used was similar in principle to that used by Rieman and van der Meulen (6).

The forces which give rise to adsorption are effective over short distances, and after the first layer of adsorbed material is formed on the oil globule, adsorption may be regarded as taking place on a surface of adsorbed emulsifying agent. There is, however, the possibility that some of the fat or oil will become a part of a complex protective film, and the methods of analysis used would not make possible a distinction between oil in the globule and oil in the interfacial film.

A hydrocarbon oil (Nujol) was emulsified in a solution of casein in water by the use of a colloid mill. The emulsions were allowed to "cream" and the concentration of casein in the total emulsion, and in the aqueous portion was determined.

The surface area of the oil globules was obtained by measuring the diameters and the numbers of oil globules in photomicrographs of several emulsions. It was found that one cubic centimeter of oil, when emulsified under the conditions described, possessed an average surface area of 6220 square centimeters. While there was some variation from this average, the result is sufficiently accurate for the purpose in mind.

The density of casein was assumed to be 1.28. In seven experiments the thickness of the adsorbed layer was found to be 4.4, 4.2, 2.2, 1.4, 2.1, 1.4, and

3.0×10^{-7} cm. The concentration of casein in the aqueous phase varied from 0.45 to 4.5 per cent by weight. The observed thickness does not seem to bear any simple relation to the concentration of casein in the aqueous phase. This is probably due to the fact that the experimental method is not sufficiently accurate to give the small differences in quantity of casein at the interface in the different solutions. The results obtained, however, are definitely of the same order of magnitude as those calculated by Wiegner (10).

·Churning Trials with Modified Creams

In these experiments we attempted to reduce the variables involved in the churning process by removing as much as possible of the normal serum solids and salts of the cream, and replacing these with other materials. The procedure used was to separate fresh morning milk, obtained from the College Farm herd, by means of a centifugal separator to produce a cream of approximately 40 percent fat content. The cream was diluted with ten volumes of distilled water and reseparated. This dilution and separation process was repeated twice. The cream obtained after three washings, and standardized to 40 percent butter fat, is referred to as "washed" cream. Attempts to remove the serum solids more completely by washing resulted in partial oiling of the butter fat from the globules of the cream.

To different portions of this washed cream were added varying amounts of stabilizing substances. The first substance added was casein, resulting in what we shall call a "casein" cream, the second substance added was a reagent grade of lecithin, giving a "lecithin" cream, and in the third case, there was added a mixture composed of equal parts by weight of casein and lecithin, producing a "casein-lecithin" cream.

Forty gram portions of the washed cream were weighed into Mojonnier composite sample bottles and to each portion in turn were added 20 cc. of the proper solution to yield the desired concentrations of casein, lecithin, and casein-lecithin mixture respectively. The control consisted of washed cream diluted with distilled water.

The bottles were then rotated gently to mix their contents, and placed in a water bath at 7.0° C. These samples were churned at this temperature, although the range of normal churning temperatures is between 13.0° C., and 16.0° C. Earlier experiments had shown that the churning times of washed creams, with, and without added interglobular ingredients are increased as the churning temperature is lowered, and the differences in the churning times of different samples are thus observed more readily. Nevertheless, it should be borne in mind that the results described are for a specific temperature of 7.0° C.

Washed cream controls, prepared by mixing distilled water with no added interglobular ingredients, with washed cream, in the proper proportions, were included in each series of churning trials.

A shaking machine with provision for shaking 30 bottles at a time was placed in an atmosphere adjusted to 7.0° C. The filled bottles previously held at 7.0° C. were fastened in the carrier so that their distinguishing marks were always visible.   The machine was started and was allowed to run until all the samples were churned.   The churning time was taken to the nearest half minute. · A sample was considered "churned" as soon as the walls of the bottle began to "wash clear."

The results of these churning trials were recalculated on the arbitrary basis of churning time of "washed" cream controls, taken as unity.   These results are shown in Fig. 1.

RELATIVE CHURNING TIMES OF CREAMS AT 7°C.
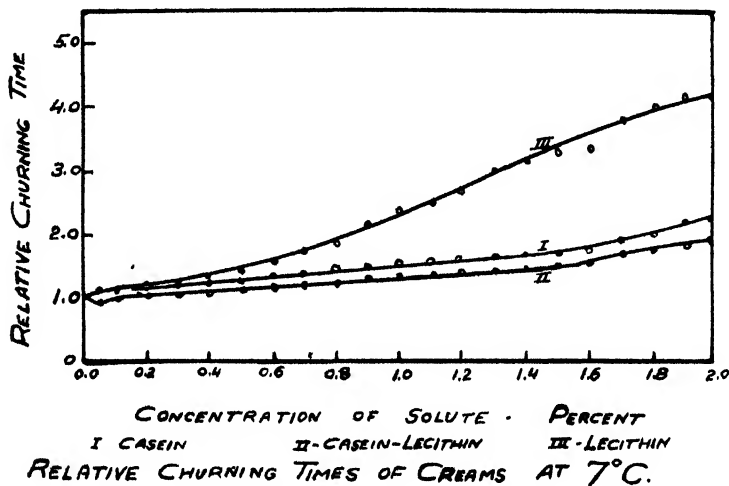
FIG. 1.

We have, here a series of results of churning creams which are considerably simpler than are creams ordinarily churned.   Although the interglobular liquid is different from ordinary creams, the actual phenomena of churning, and the butter produced, show the same characteristics as those usually observed.   These data, therefore, present an interesting opportunity for studying the effect of the electric charge carried by the globule, and of the viscosity of the interglobular liquid, on the rate of churning.

The Effect of the Electric Charge Carried by the Globules on Churning Time

Since the electric charge on the globule is determined by the substance adsorbed on the fat globules, any change in the interglobular liquid may bring about a change in this charge.

One cubic centimeter of washed cream was diluted to 250 cubic centimeters with interglobular solution, and this solution was used in the electrophoresis experiments.   A portion of washed cream diluted with distilled

water served as a control, and the results are expressed on the basis of this control.

An all glass, flat electrophoresis cell, of the closed type was used, with copper electrodes in combination with a normal solution of copper sulfate. The rate of movement of globules was measured by timing the movement of the image of globules between fixed lines in the field, using a stop-watch. It was found that medium sized globules could be observed with greater accuracy than either large or small globules. The experiments were carried out at 30° C., and rate measurements were made of globules at three levels of the cell, namely at the middle, at one third, and at one sixth of the depth of the cell.

The following formula (1) gives the rate of movement of globules in an electric field.

$$V = \frac{\zeta \; D \; X}{4\pi \; \eta}$$

where ζ = electrokinetic potential
D = dielectric constant
X = potential gradient
η = viscosity of the medium

For a constant potential difference, a constant dielectric constant, and in the same apparatus, we have

$$\frac{\zeta_1}{\zeta_2} = \frac{V_1 \; \eta_1}{V_2 \; \eta_2}$$

If we take ζ_2, the electrokinetic potential of washed cream as an arbitrary standard, we can express the charge on the fat globules as the relative electrokinetic potentials in terms of the washed cream taken as unity. The

CONCENTRATION OF SOLUTE - PERCENT

I - CASEIN   II - CASEIN - LECITHIN   III - LECITHIN.

RELATIVE ELECTROKINETIC POTENTIALS OF GLOBULES
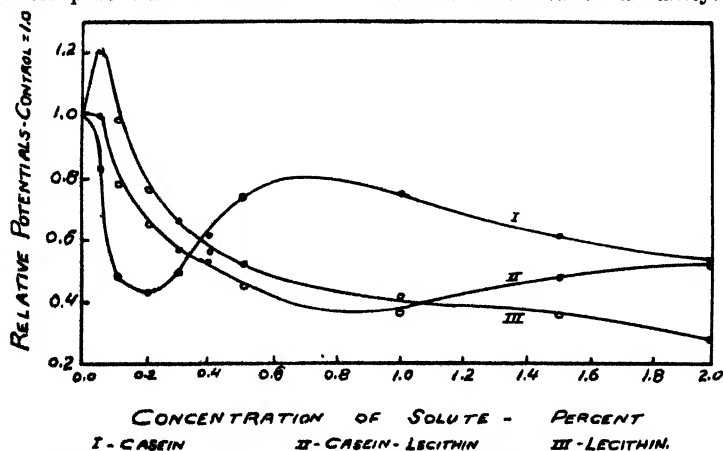
FIG. 2.

viscosities of the interglobular liquids was taken, at 30° C., with an Ostwald viscosimeter. The electrokinetic potentials determined at the three levels were averaged for each series of measurements, and are given in Table 1, and are shown graphically in Fig. 2.

TABLE 1

Average relative electrokinetic potentials on butterfat globules in solution of casein, lecithin, and casein-lecithin mixtures

CONCENTRATION OF SUBSTANCES DISSOLVED IN WATER	CASEIN	LECITHIN	CASEIN AND LECITHIN
per cent			
0.05	0.83	1.21	0.99
0.10	0.48	0.98	0.78
0.20	0.43	0.76	0.76
0.30	0.50	0.66	0.57
0.40	0.61	0.55	0.53
0.50	0.74	0.52	0.45
1.00	0.74	0.42	0.37
1.50	0.61	0.35	0.48
2.00	0.53	0.28	0.53

NOTE: Figures are averages of relative values based on washed cream diluted with distilled water, taken as 1.00.

A comparison of the results shown in Fig. 2, with those represented in Fig. 1, which gives relative churning times, shows that the electric charge on the butter fat globule has either no effect, or a very minor one, on the churning process. One would expect that reduction of the like charges on the globules would increase the ease of their agglomeration; the results of the electrophoresis trials indicate that this property is of minor importance.

CONCENTRATION OF SOLUTE - PERCENT
I - CASEIN   II - CASEIN-LECITHIN   III - LECITHIN
RELATIVE VISCOSITIES OF SOLUTIONS AT 7°C.
FIG. 3.
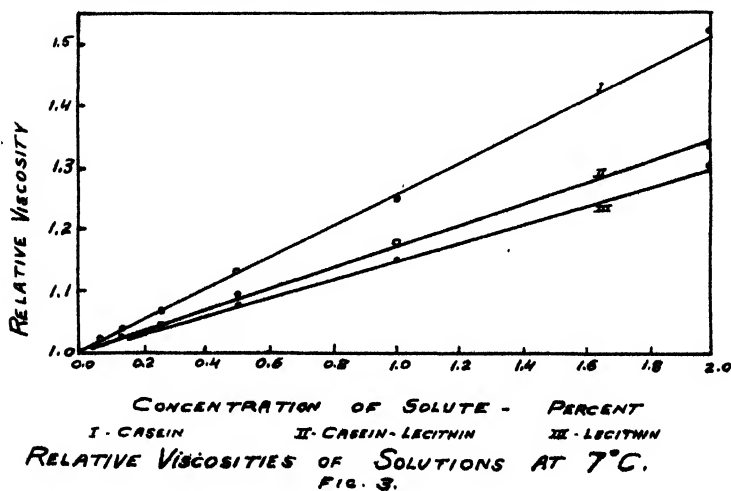
The Effect of the Viscosity of the Interglobular Liquid on Churning Time.

Interglobular solutions were prepared of casein, lecithin, and casein-lecithin, and the viscosities were determined as 7° C., the churning temperature. The determinations were carried out by means of the Ostwald pipette, and the results are expressed as relative viscosities based on the viscosity of distilled water, at 7° taken as unity. The results are given in Table 2 and in Fig. 3.

It will be noted that the relative viscosity is a linear function of the concentration in all three cases. The viscosity of the casein solution is greatest, that of the lecithin smallest, and that of the casein-lecithin is intermediate, but nearer that of lecithin.

TABLE 2

PERCENT SOLUTE	RELATIVE VISCOSITY (WATER AT 7° C = 1)		
	Casein solution	Lecithin solution	Casein-lecithin solution
0.0625	1.025	1.012	1.010
0.125	1.038	1.018	1.022
0.25	1.065	1.039	1.046
0.50	1.133	1.074	1.098
1.0	1.255	1.152	1.183
2.0	1.529	1.309	1.337

A comparison of the results for churning times and viscosities shows that the casein modified creams have a much higher viscosity than the lecithin modified creams, but that the casein creams churn more quickly.

DISCUSSION OF RESULTS

The fact that a reduction of the electric charge on the globules does not hasten churning may be interpreted in at least two ways. It may be that the residual charges, even on the globules which carry the smallest charges, are still so large that the globules have little if any increased tendency to coalesce, or that the kind of agglomeration which takes place is not governed at all by the charge on the particles, but is a phenomenon dependent on a change involving an electrically neutral substance.

The rate of drainage of the interglobular liquid from the foam must be inversely proportional to the viscosity of the liquid. It is surprising that the increase in viscosity has so little effect on the rate of churning. It may be that actual clumping of the globules does not depend on complete or nearly complete drainage of the liquid from the foam structure.

It appears that the specific properties of the film surrounding the globules are of the greatest importance in the churning process. A similar conclusion is reached by Rahn (5), but our results indicate that Rahn places too much emphasis on the importance of his hypothetical "foam substance." Washed cream churns much more easily than normal cream. If churning

depends on the irreversible coagulation of "foam substance" it is difficult to explain this result. Furthermore, the introduction of casein and lecithin, in relatively large quantity into the cream, replacing the normal interglobular solutes does not seem to alter the essential features of the churning process.

Our results can be explained satisfactorily by assuming, as Rahn does that the first step in the churning process leads to the production of a foam, containing a high concentration of fat globules, and that in the second step a large proportion of the milk serum drains from the foam. Rahn assumes that the next step is the irreversible coagulation of the "foam substance," resulting in the formation of a rigid structure containing globules of butter fat still stabilized by their original protein films. Instead of assuming that this irreversible coagulation of a hypothetical foam substance is the next step, we assume that, as a result of the mechanical action of the churn, the stabilizing films of some of the fat globules are broken, liberating the oil from the least stable globules, but leaving the more stable globules essentially unchanged. The free oil produced by the rupture of the least stable globules forms a cementing material for the stable globules in its immediate vicinity.

The stage in which this rupture and initial cementing takes place is the stage ordinarily recognized as the "breaking point." Such a spreading and cementing would take place equally well on a globule with a large charge as on one with a small charge, and would not be governed by the viscosity of the interglobular liquid. It would, therefore, explain the apparently negligible effect which electrical charge on the globules, and viscosity of the medium have, on the churning time.

The Production of Butter without Churning

If the view which we have expressed is correct, that the conversion of cream into butter does not depend on "foam substance" coagulation, but rather on the production of a certain proportion of unstable globules, it should be possible to produce butter without churning. All that is necessary is to bring about a condition in which a part of the globules are caused to set free their fat, in the presence of stabilized globules.

The stability of the globules in a cream is lowered by decreasing the concentration of serum solids, and by raising the temperature. Therefore, by proper dilution and elevation of the temperature, followed by centrifuging, we should obtain butter directly from a cream separator.

In a particular experiment, forty percent cream was diluted with ten volumes of water, and warmed to 125–130° F. It was then passed through a centrifuge, which had been adjusted to reduce the rate of flow by constricting the orifice of the milk reservoir, and to increase the concentration of butter fat in the cream by turning the cream screw. The cream outlet of the separator was warmed to keep the fat in a liquid state. Under these

conditions the product which issues from the separator is butter, that is, it is not redispersed by stirring with water, and was identified as butter by several individuals, skilled in the art of butter-making. Its consistency can be controlled within wide limits by regulating the dilution and temperature of the cream. In this process we do not have the possibility of denaturation of the "foam substance," and yet the product is the same as that produced in the classical churning method.

SUMMARY

1. A study of the distribution of casein between water and a mineral oil-water interface tends to confirm the conclusion of Wiegner with respect to the thickness of the interfacial film.

2. Results are described, obtained in churning certain modified creams. The relative electrical potential on the butter-fat globules, and the viscosity of the interglobular solutions were determined. These two factors appear to have very little, if any, effect on churning time.

3. It is suggested that churning is due to the setting free of butter fat from the less stable globules, followed by a cementing of the more stable protected globules into clumps, by the free butter fat.

4. In support of this view, we have been able to produce butter, without churning under conditions that favor a decrease in stability of the fat globules.

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THE EFFECT OF TEMPERATURE AND TIME OF STORAGE OF CREAM ON THE RATE AND TYPE OF DETERIORATION[1]

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INTRODUCTION

The deterioration of cream from the time it is produced until it is finally made into butter has always been a problem of vital concern to the butter-maker. This problem is particularly important in those sections of the country served by the centralizer type of creamery, where the volume of cream produced per farm is often too small to expect daily deliveries. The cream is held on the farm for a period of time, sometimes a week or more, before it reaches the creamery. The conditions under which it is held, therefore, will have a direct bearing on the rate and amount of deterioration. The problem is accentuated during the seasons when high temperatures prevail. In the absence of adequate cooling facilities the cream will spoil very rapidly. If the spoilage is allowed to proceed until second grade cream results, the producer may be penalized; or if the cream should be condemned as unfit for butter-making purposes, he may suffer even a greater loss.

The factors responsible for the deterioration of cream are generally known. For many years cream producers have been advised to use sanitary methods of production, to cool cream and hold it at a temperature which will retard or prevent the growth of microbes which are agents of spoilage, and to market the cream frequently. There is, however, a lack of information on certain phases of the cream spoilage problem. The type of fermentation which takes place in cream, the extent to which it will proceed, and the by-products formed will depend upon the type of organisms present in the cream and upon time and temperature of holding. In the spoilage of cream the extent of microbial activity may be determined in various ways. The sense of taste and smell will detect off flavors and odors which may develop in the cream and make it possible to classify the cream into grades. The acidity determined by titration or by the pH method and the formol titration are tests which measure the amount of by-product of bacterial activity in the cream. Yeast and mold counts give some information regarding the care exercised in the production and handling of the cream.

It was the purpose of this experiment to study the relationship of temperature to the above factors.

METHODS

In each trial a thoroughly mixed sample of No. 1 grade, sweet cream (35 per cent fat) was divided into nine equal portions and placed in separate incubators adjusted to operate at 50, 55, 60, 65, 70, 75, 80, 85, and 90° F., respectively. The various lots of cream were held at the indicated temperatures for 16 days or until they became third grade. In two of the trials (1A and 1B) the 55° F. and 85° F. temperatures were not used. The samples which were removed daily for use in grading and testing were labeled in accordance with a system of key numbers in order to conceal their identity and eliminate the inevitable personal factor when organoleptic methods are employed.

After each sample had been graded independently by three persons, an official grade was determined by mutual agreement or, if necessary, by reexamination of the sample.

The pH determinations were made by the quinhydrone method. The acidity calculated as lactic acid was determined by titrating duplicate 9 gram portions with 0.1 normal NaOH, using phenolphthalein as the indicator.

After neutralizing the samples to the end-point of phenolphthalein for the acidity test, 10 ml. of commercial formaldehyde (30–40 per cent HCHO), which previously had been neutralized to the end-point of phenolphthalein, was added to the cream and the mixture was again titrated to the end-point of phenolphthalein with 0.05 normal NaOH. This second titration known as the formol titration is expressed arbitrarily as the ml. of 0.05 normal NaOH required to neutralize the carboxyl groups freed as a result of the union of formaldehyde with the amino groups of proteins decomposed by biochemical processes.

In two of the trials yeast and mold counts were made on Difco dehydrated whey agar incubated five days at 70° F.

In one of the trials a sample of cream of poor sanitary quality was divided into two equal parts and 10 per cent of butter culture was added to one of the parts before subdividing each into nine smaller portions for incubation at the indicated temperatures. Since more than 5000 determinations were involved only typical data are presented.

The definitions given in the Kansas dairy law for cream grades were used as a basis for grading. First grade cream is defined as cream that is clean, smooth, free from undesirable odors, clean to the taste, and sweet or only slightly sour. Second grade cream is described as cream that is too sour to grade as first, that contains undesirable flavors and odors in a moderate degree, that is foamy, yeasty or slightly stale, or that is too old to pass as first grade. Third grade cream, or unlawful cream, consists of cream that is very old, rancid, moldy, dirty or curdy, which contains or has contained any foreign matter, or in which has been found unsanitary articles or utensils.

RESULTS

Changes Occurring During Storage

The holding of cream at various temperatures resulted in a change in the grade of the cream. Storage also affected certain chemical and bacteriological changes in the cream. Aside from the quality of the cream at the beginning of each trial the temperature and time of holding were largely responsible for the degree and extent to which these changes took place.

Grades. When cream was held at 50° F. it required from 11 to more than 16 days for it to become second grade. In contrast, at 90° F. only 1 to 4 days, with an average of 2 days, were required for a similar change in grade. The average time for change from first to second grade when the storage temperature was 70° F. or above was from 2 to 6 days (Table 1). In trials 2 to 6B (Table 2) the cream was purposely held until it became

TABLE 1

Days required for cream to change from first to second grade

TRIAL NO.	TEMPERATURE OF INCUBATION (°F.)								
	50	55	60	65	70	75	80	85	90
1–A	14		9	7	7	5	4		2
1–B	14		8	10	10	4	3		3
2	16*	9	9	9	3	2	2	2	2
3	11	8	7	3	4	3	2	2	2
4	16*	16*	16	15	8	8	6	4	4
5	15	15	15	12	8	6	5	3	4
6–A	14	9	10	9	7	6	3	3	2
6–B	16*	10	7	6	4	4	2	2	1
Average	15	11	10	9	6	5	3	3	2

* Still first grade cream 16th day but considered second grade in computing averages. No observation after 16th day.

third grade. It was found that cream held at 50° F. still graded second after 16 days of holding (Table 2). When the storage temperature was varied by 5° intervals between 50° F. and 90° F. the time required for cream to become third grade varied from 4 to more than 16 days.

Whenever it was possible to do so the judges noted the specific defects in flavor which were present. These defects were arranged in tabular form corresponding to the various trials and holding temperature. From this record it was possible to compile the figures presented in Table 3 showing the length of time required for various flavor defects to develop.

It required from 1 to 6 days for the cream to become sour. At the higher temperatures souring took place in a comparatively short time, and at the lower temperatures the best quality cream remained sweet for several days. Stale flavors were most prevalent in cream held for a considerable length of time at 75° F. or below, but in some instances this defect was not noted

TABLE 2

Days required for cream to change from first to third grade

NO TRIAL	TEMPERATURE OF INCUBATION (°F.)								
	50	55	60	65	70	75	80	85	90
2	16*	11	12	16	10	9	6	6	5
3	16*	16	14	10	10	8	5	4	3
4	16*	16*	16*	16*	10	10	7	6	4
5	16*	16*	16*	15	10	10	7	4	4
6–A	16*	16	16*	14	10	7	4	6	4
6–B	16*	16*	12	6	4	6	4	6	4
Average	16*	15	13	13	9	8	6	5	4

* Still second grade cream on 16th day but considered third grade in computing averages. No observations after 16th day.

until from 7 to 14 days of storage (Table 3). Putrid flavors resulting from protein decomposition may take place at extremely high or extremely low temperatures. At intermediate temperatures 60 to 75° F. inclusive, the flavor was not found, indicating that different organisms may be responsible for the development of this flavor.

. A flavor recognized as bitter was present quite frequently in the cream after 1 to 14 days of storage. The development of this defect was retarded by storage at low temperatures, although in some instances it appeared after 2 or more days of storage (Table 3). Another defect which showed up during the early stages of holding in many samples was designated by the term unclean. Rancidity was noticeable in the cream stored at 70° F. or above after 3 to 7 days. It appeared in 7 to 9 days in cream held at 60 and 65° F. At the two lowest temperatures rancidity did not develop, probably due to the inability of fat splitting enzymes to act.

TABLE 3

Minimum and maximum number of days required for specific defects to develop when and if they appeared in the cream held at various temperatures

(8 Trials)

FLAVORS	50 °F.	55 °F.	60 °F.	65 °F.	70 °F.	75 °F.	80 °F.	85 °F.	90 °F.
Sour	2–6	2	1–3	1–3	1–2	1–2	1–2	1	1–2
Stale	4–13	4–9	4–14	4–14	6–9	7		2	
Putrid	9–20	14					4		4
Bitter	2–10	4–14	2–9	1–10	2–8	1–10	1–4	·2–7	1–4
Unclean	3–9	2–6	2–8	2–13	2–8	2–7	1–4	2	2–3
Musty	15	10–15	7	10		6		. .	
Rancid			8	7–9	4	7	4–7	3–7	4–5
Cheesy		5	.	3	3–11	4–11	2–6	3–5	1–3
Yeasty		14	11–12	7–15	4–9	4–8	6–7	4–5	4–5

With one exception cheesy flavor was confined to cream stored at 65° F. or above, appearing quite early in cream held at 70° F. or above. Yeastiness, a common flavor defect of cream held at high temperatures, appeared in 4 to 5 days in cream held at 85 and 90° F. but as the holding temperature was reduced the appearance of the defect was retarded, 7 to 15 days being required for its presence at 65° F. At 50° F. no yeast flavor was noted. Certain flavor defects seem to appear at a rather fixed time when cream is held at any one of the various temperatures. If this is true, it should afford a possible index to the age of cream and the conditions under which it has been held.

Acidity. In many states the maximum titratable acidity* which will be tolerated in first and second grade cream is stipulated by law.

TABLE 4

The acidity of cream at the time it was classed as second and as third grade

TEMPERATURE OF HOLDING	PER CENT ACIDITY WHEN CREAM WAS CLASSED AS SECOND GRADE				PER CENT ACIDITY WHEN CREAM WAS CLASSED AS THIRD GRADE			
	Trial number				Trial number			
	4	5	6A	6B	4	5	6A	6B
50° F.	*	.49	.49	*	*	*		*
60° F.	*	.49	.60	.78	*	*		.78
70° F.	.72	.70	.79	1.05	.89	.93	1.26	1.05
80° F.	.83	.95	1.01	.80	.98	1.28	1.23	1.28
90° F.	1.03**	1.08**	.84	.94	1.03	1.08	1.62	1.83

* Not second grade after 16 days.
** Graded as third without a second grade period.

The data in Table 4 show the titratable acidities of each of four samples of cream held at 50, 60, 70, 80, and 90° F. when each was classed as second or as third grade cream. At the lower temperatures (50 and 60° F.) the cream was regarded as second grade at lower levels of acidity than the cream held at the higher temperatures. These data suggest that the establishment of a fixed value for the maximum acidity of cream of a given grade should take into consideration the possible effect of the temperature of storage on the type of changes which take place in the cream. Cream held at the lower temperatures was graded as second or third grade only after a prolonged period, during which time defects other than acidity had developed. In the higher ranges of temperature the rapid development of acidity not only resulted in an objectionable sharp, sour flavor but the changes in hydrogen-ion concentration apparently catalyzed other objectionable chemical or biochemical processes.

If cream is held at temperatures of 60° F. or below, an acidity in excess of approximately 0.6 per cent might be regarded as a fair index to second grade cream. Cream samples held at a temperature of 70° F., however, were

* The term acidity used throughout this article refers to titratable acidity.

not graded as second until acidities had reached 0.7 per cent or more, indicating that at the higher temperatures an acidity of approximately 0.8 might be a better index of grade. The rapidity of the biological and chemical changes in cream held at the higher temperatures may not have permitted accurate determination of the actual acidity at which the cream became second or third grade, especially when the interval between examinations was 24 hours.
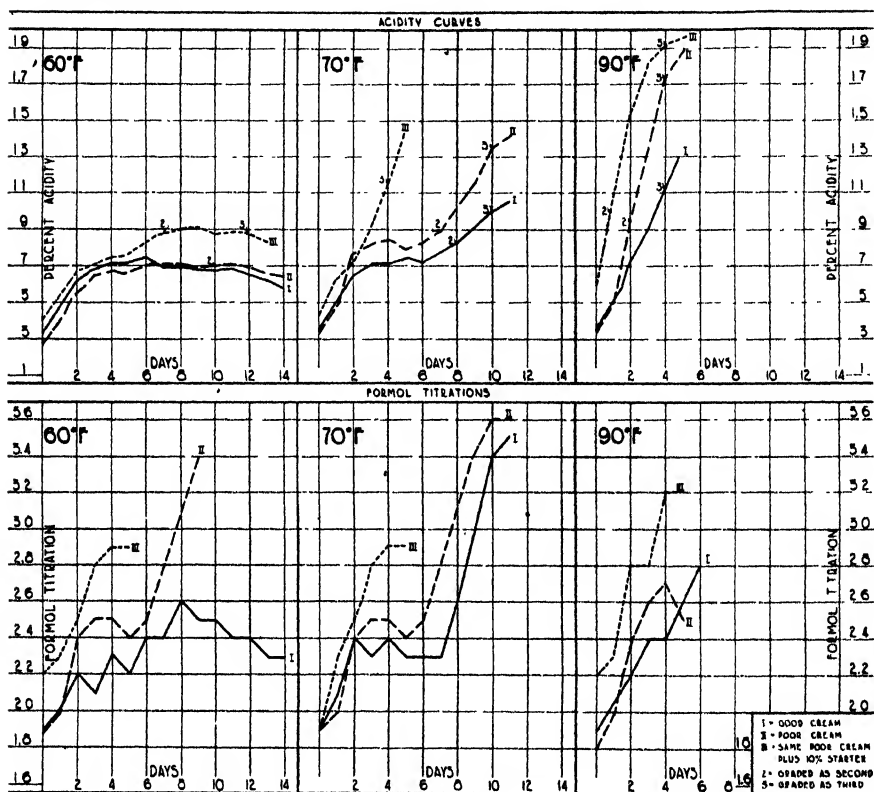
FIG. 1. EFFECT OF TEMPERATURE, QUALITY OF CREAM, AND ADDED STARTER ON THE TITRATABLE ACIDITY AND FORMOL TITRATION OF CREAM.

The three charts in the upper half of Figure 1 show the rates of development of acidity in three of the samples of cream held at 60, 70, and 90° F. The solid lines designated by Roman numerals I, show the trends of acidity at the indicated temperatures in a split sample of cream produced and handled under careful conditions; the dash lines, labeled II, show the rates of development of acid in sweet cream of poor quality. The dotted lines labeled III refer to acidity curves for the same cream as II except that 10

per cent of butter culture was added prior to incubation. The Arabic numerals (2 and 3) indicate the time at which the cream was classed as second and/or third grade.

A study of the acidity curves shows several interesting facts.

1. At 60° F. the acidity of the poor cream (II) increased only slightly more rapidly than that of the good cream (I). The maximum acidity of approximately 0.7 per cent was attained by the fourth day and was maintained thereafter without further increase. The acidity of the cream to which starter was added (III) increased steadily for 8 days to approximately 0.9 per cent.

2. At 70° F. there were greater differences in the rates of development of acidity in the good cream, poor cream and poor cream plus starter than were noticed at 60° F. The addition of starter greatly stimulated the rate of acid development and hastened the time when the cream was classed as third grade or illegal cream.

3. At 90° F. the rate of acid development and per cent acidity attained was much greater than at the lower temperatures. The acidities at which the poor cream and the poor cream plus starter were classed as third grade were noticeably higher at high temperatures than for the same cream incubated at lower temperatures.

4. A general study of all three graphs points out clearly the importance of temperature of storage on the rate of development of acid in cream, its effect in magnifying the differences between good and poor cream especially after the second day of storage, and the fallacy of establishing a fixed maximum acidity as the line of demarcation between first and second or second and third grade cream.

pH Determinations. The data for the pH determinations show in a general way the same points as are demonstrated in the acidity curves and for this reason they are not presented in tabular or graphic form. The ·hydrogen ion concentration of the cream decreased rapidly during the first 2 days to a value of about pH 4.6 and then continued to decrease at a slower rate as might be expected from a study of the acidity curve of the same sample. The pH values afforded less information about the condition of the sample than the acidity curves, due to the fact that the pH dropped quickly to a minimum during the first few days of storage then showed little change thereafter.

Formol titrations. The three charts at the bottom of Figure I show the results of formol titrations on the same samples for which acidity curves are presented at the top of the figure. On the assumption that the formol titration reflects the extent to which proteins have been broken down into simpler components, particularly amino acids, the following observations may be made from the curves presented in Figure 1.

1. At 60° F. the rate and amount of protein decomposition was less in

the good cream (I) than in the poor cream II, and the addition of starter (III) accelerated proteolysis.

2. At 70° F. there is a noticeable parallelism between the formol titration curves and the corresponding acidity curves in the upper part of Figure 1.

3. At 90° F. proteolysis as revealed by the formol titration was accelerated at about the same rate as the acidity.

4. The differences in the rate of proteolysis in the poor cream (II) and the good cream (I) is more marked at the lower temperatures than at the higher.

5. The addition of starter tended to stimulate proteolysis at all temperatures of storage and the effect was noticeable from the beginning of the storage period.

Yeast and mold counts. In Figure 2 the logarithms of the yeast counts and of the mold counts have been plotted for one of the sets of samples. At 50° F. there was little, if any, growth of yeasts or molds. At 60° F. there were a maxima of 100 yeasts and 100 molds per ml. (log. = 3) in 6 and 8 days, respectively. At temperatures of 70, 80, and 90° F. the growth of these forms was definitely stimulated. The graphs in Figure 2 confirm the statement commonly made by creamerymen that any cream not refrigerated during the warm months of the year may become yeasty after the second or third day.

DISCUSSION

Observations made on a large number of cream samples has given some indication of the time required for cream to become second and third grade when held at various temperatures from 50° F. to 90° F. inclusive. By actually tasting and grading the cream daily some knowledge has been gained regarding the nature of the off flavors which predominate in the cream at any particular time. Because of the variations in the original quality of the cream and the microbial flora present it is impossible from the above data to state definitely how long cream will remain first grade or second· grade.

The prolonged holding of cream at low temperatures (below 60° F.) does not result in the development of high acidities, regardless of the original quality of the cream. Undesirable off flavors, such as stale, bitter, and unclean, will eventually appear and result in a second grade cream. Under these conditions the producer may minimize the importance of frequent deliveries and proper sanitary methods; however, attention to both is essential if a high quality cream is desired. Cream of good sanitary quality held on the farm, at 65° F. or below should remain first grade for at least one week. Two weeks' storage may result in third grade cream.

Since facilities for holding cream at 65° F. or below are not available on many farms, it is imperative that the strictest attention be paid to careful production and frequent marketing. Off flavors appear in the cream early
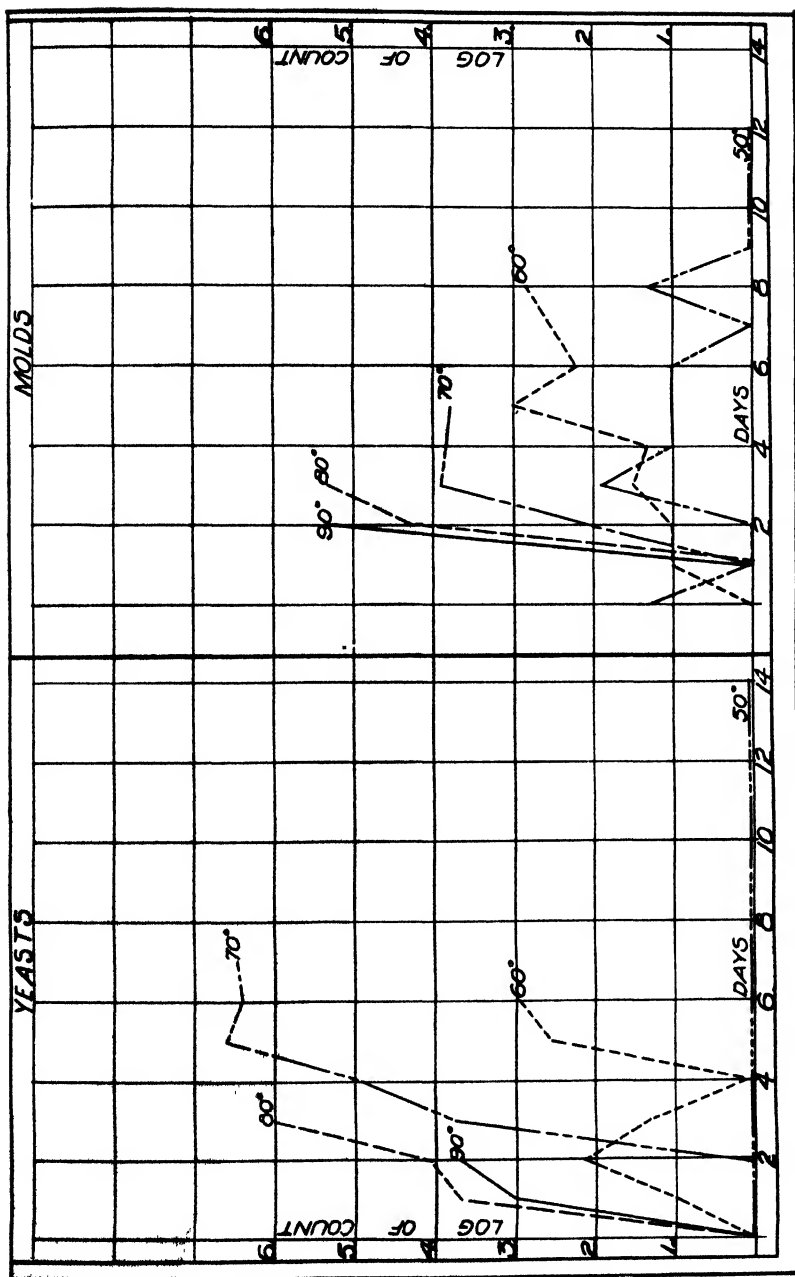
Fig. 2. Effect of Temperature on Rate of Growth of Yeast and Molds in Cream.

in the storage period because a 70° F. temperature is favorable for bacterial growth. By keeping the bacteria out of cream, the bad effects of the higher storage temperature may be lessened to a certain degree.

The undesirable effects of holding cream at high temperatures is clearly demonstrated by the rapidity with which the cream becomes second and third grade and by the seriousness of the off flavors which appear. The injury to cream which results from high storage temperatures may be minimized by use of the evaporation method of cooling. It may be possible by lowering the temperature of the cream 10 to 15° F. to delay the formation of yeasty, cheesy, bitter, rancid, and unclean flavors. The marketing of cream at frequent intervals is advised if conditions necessitate the holding of cream at high temperatures.

The results showing the per cent acidity in cream when it became second or third grade, indicate the possible fallacy of applying a fixed acidity as an index to grade. A rather definite parallelism existed between the storage temperature and the acidity of the cream when classed as second grade. The higher the storage temperature the higher the acidity at the time of change in grade from first to second or from second to third grade.

At the lower storage temperatures the differences in the rate of development of acid in good cream and poor cream were not great, but at 70° F. or above the poor cream showed definitely more rapid development of acidity. The addition of starter to cream increased the rate of development of acid and also shortened the time required for cream to be degraded.

The daily determination of the hydrogen-ion concentration of cream held at various temperatures yielded little information not already revealed by total acid determinations.

Results with the formol titrations showed an apparent relationship with the acid development in the cream. These observations suggest that either the formol titration may be influenced by the acidity, or that the presence of the acid may stimulate proteolysis. The fact that the addition of starter to cream accelerated the rate and amount of acid development, increased the formol titration, and decreased the time required for the cream to be classed as second or third grade by organoleptic methods lends strong support to the assumption that in this instance acid tended to stimulate proteolysis. It has been rather generally agreed that proteolytic processes are retarded by increase in acidity. However, it is common knowledge among the cream graders that many defects of cream such as cheesiness await the development of high acidities.

The assumption that the formol titration reflects the extent of protein decomposition may be defensible on theoretical grounds, but it does not necessarily follow that all of the proteolytic processes which contribute to high formol titration values are of an undesirable character. This conclu-

sion is supported by the fact that the early fermentation products of a good butter culture improve the flavor of butter and at the same time the acid may accelerate proteolysis.

If the formol titration value is increased in cream by a commonly accepted practice such as the addition of starter, one should exercise caution in concluding that the formol titration always reflects an undesirable condition. Until the limitations of the formol titration have been established by determining the parallelism between these values and the actual quality of the cream for buttermaking, it would be advisable to withhold strict interpretation of the index value of the test.

SUMMARY

The results may be summarized as follows:

1. When cream was held at 50° F. it changed from first to second grade in from 11 to 16 or more days. At 70° F. it changed in from 3 to 10 days, and at 90° F. in from 1 to 4 days. The time required for the cream to change from first to third grade varied from 4 to more than 16 days as the temperature was varied by 5° intervals between 50 and 90° F.

2. The cream soured in from 1 to 6 days, souring more rapidly as the storage temperature increased. Stale flavors were most prevalent at low storage temperatures after several days (4-14) holding. Putrid flavors were detected at high or low temperatures but not at intermediate temperatures (60-75° F.). Bitter flavor varied widely in time of appearance (1 -14 days) but apparently was retarded at low temperatures. Unclean flavor appeared early. Rancidity was not detected in cream stored at 50 to 55° F. but appeared in from 3 to 9 days at other storage temperatures. With one exception cheesy flavor appeared only at temperatures of 65° F. or above. Yeastiness appeared in from 4 to 5 days at temperatures of 85 and 90° F., but as storage temperatures were reduced development of this flavor was retarded.

3. At the lower storage temperatures (50 and 60° F) the cream was regarded as second grade at lower levels of acidity than when the cream was stored at higher temperatures. At 60° F. the acidity of poor cream increased only slightly faster than that of good cream, the maximum being 0.7 per cent in 4 days and remained the same thereafter. At 70 and 90° F. the rate of acid development in the poor cream was much greater than in the good cream, the rate of acid development being dependent on the storage temperature. Addition of starter to poor cream increased the rate of acidity development at all temperatures, being greatest at the higher temperature.

4. The hydrogen-ion concentration of the cream decreased rapidly during the first 2 days to a value of pH 4.6, after which the rate of decrease was less. The pH values revealed little information not indicated by tests for total acidity.

5. Formol titrations of cream held at 60° F. indicated that protein decomposition was less in good cream than in poor cream.   At higher storage temperatures proteolysis was accelerated, but the difference between the rate in poor and good cream was more marked at lower temperatures.   Addition of starter to poor cream caused an increase in the formol titration at all temperatures.   Data presented raises a question regarding the validity of the formol titration as an index of undesirable conditions.

6. Practically no yeasts or molds developed in cream held for 16 days at 50° F.   At temperatures of 70° F. or above mold and yeast development increased rapidly.

REGULATING THE FEEDING OF CERTAIN ROUGHAGES TO MINIMIZE THEIR INFLUENCE ON THE FLAVOR OF MILK

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INTRODUCTION

Most roughages have been shown to cause flavor in milk when appreciable quantities are consumed by dairy cows within one to five hours before milking (1). The general recommendation has been to withhold from cows all flavor produceing feeds such as clover and alfalfa during the five hour period before milking. It is recognized that if superb flavored milk is to be produced, such a procedure is necessary. The general milk supply at present, however, is not produced according to this standard. The experiments reported in this paper were designed to arrive at a feeding procedure that would not be burdensome and expensive for the dairyman to carry out and yet would make it possible for him to produce milk with a flavor that would be acceptable to the average consumer.

EXPERIMENTAL

Source of the Milk: A college herd of 19 cows was used in the different feeding trials. The herd consisted of fifteen Jerseys, three Holsteins and one Ayrshire. All of the cows were registered pure breds and were producing milk which was normal in flavor. The cows were milked by machine and the milk was cooled immediately after milking by being passed over a brine external tubular cooler. The samples used for scoring were taken as composites from the milk of the entire herd.

Scoring the Milk: The milk samples were scored as unknown by four judges. In order to satisfy the requirement for statistical analysis that bias be removed from the experiment, the "unknowns," consisting of controls and experimental samples, were placed in random order for scoring.

The controls consisted either of composite milk samples taken from the herd when no roughage was fed during the five hour period before milking as described under Regime 1, or of samples taken from the morning milking after the cows had consumed an average of 0.8 pound of alfalfa hay during the five hour period before milking. The average flavor score when all roughage was withheld during the five hour period before milking was 22.85, and was 22.70 when an average of 0.8 pound of alfalfa hay was consumed during this period. The score card used was that of the American Dairy Science Association (2) which allows 25.00 points for a perfect score. In accord with the general custom in the use of the score card, a score of 23.00

was considered an average for milk that could not be criticized as having a flavor defect.

The milk was heated to a temperature of approximately 100° F. for scoring.

The flavor scores were subjected to statistical analysis and conclusions are based on this analysis.

Feeding Regimes: The experiment was divided into eight feeding regimes as indicated in table 1. The concentrate ration mentioned in the descriptions of the feeding regimes consisted of eight parts rolled barley, two parts beet pulp, two parts coconut meal and one part cottonseed meal. Such a mixture, when fed one or two hours previous to milking, has been found not to materially affect the flavor of milk (1). In regimes 2, 3, 6, and 7 "free access to alfalfa hay" means that a fresh supply of alfalfa hay was placed in the feeding racks twice daily before the cows were removed from the milking stable following milking. The hay was thus available to them immediately after milking.

TABLE 1

Average flavor scores of milk produced during the different feeding regimes

FEEDING REGIME	FEED CONSUMED DURING FIVE HR. PERIOD BEFORE MILKING (POUNDS)	NUMBER OF SAMPLES	NUMBER OF SCORES	AVERAGE FLAVOR SCORE
1. Control, no roughage during five hour period before milking; concentrates fed before milking.			29	22.85
2. Free access to alfalfa hay. Concentrates fed before milking Corn silage fed after milking	Alfalfa, a.m. 0.8# Alfalfa, p.m. 3.8#	38	150	22.61
3. Free access to alfalfa hay. No concentrates or corn silage fed.	Alfalfa, a.m. 2.4# Alfalfa, p.m. 4.0#		29	22.65
4. Free access to alfalfa pasture during day time between milkings.		10	32	21.99
5. Free access to alfalfa pasture both day and night			24	22.45
6. Free access to alfalfa hay. Concentrates and corn silage fed before milking.	Corn silage, 14.2#	10	40	22.25
7. Free access to alfalfa hay. No concentrates fed. Corn silage fed at milking time.	Corn silage, 18.9#	6	24	21.83
8. Free access to Sudan grass pasture during day between milkings.			24	22.55

RESULTS

The data (Table 1) show that when the cows were given free access to a fresh supply of alfalfa hay immediately after milking in feeding regime 2, a very small amount of the hay was eaten during the five hour period before the morning milking, and a somewhat larger amount was consumed in the five hour period before the afternoon milking. The flavor score indicates that the flavor of the milk produced during this regime was not quite equal to that produced when all roughage was withheld during the five hour period prior to milking as in regime 1. The flavor, however, was considered to be acceptable for ordinary market milk purposes. Roadhouse and Henderson (1) have previously shown that five pounds of alfalfa hay fed two hours before milking, produced a distinct and undesirable feed flavor in milk and that the average flavor score was 22.00. Ten pounds of alfalfa hay fed two hours before milking produced a strong, undesirable feed flavor in milk and the score was reduced to an average of 20.50.

When the herd was pastured on alfalfa during the interval between the morning and afternoon milkings, the flavor score was affected seriously enough to justify the practice of removing the cows from the pasture a sufficient time previous to milking to avoid objectionable feed flavor in the milk. When the cows were pastured on alfalfa both day and night, the flavor score was not seriously affected. This result is interpreted to mean that when the cows had access to alfalfa pasture twice a day they consumed their requirements for roughage in the first hours on pasture and that they did not consume sufficient feed in the later hours to seriously affect the flavor of the milk. The authors (1) have shown that ten pounds of green alfalfa fed two hours before milking caused a distinct and undesirable feed flavor in milk with the flavor score averaging 22.00. This is approximately the score of the milk produced during feeding regime 4 when the cows were pastured on alfalfa during the day only.

In feeding regime 6, corn silage was fed at milking time. An average of 14.2 pounds per cow was consumed and the flavor score of the milk averaged 22.23. In regime 7, concentrates were not fed and the cows consumed an average of 18.9 pounds with the flavor score being reduced to an average of 21.83. In this case the flavor was distinct and was considered to be undesirable in market milk. When such amounts of corn silage are fed it should be given after milking if good flavored milk is to be produced. The authors (1) have previously shown that as little as five pounds of corn silage fed one hour before milking caused an after-flavor in the milk but not a distinct feed flavor.

When the cows had free access to Sudan grass pasture during the interval between the morning and afternoon milkings, the flavor of the milk was not considered objectionable and the flavor scores averaged 22.54.

The average flavor score of the judges for the milk produced during each

feeding regime and the average score of the four judges for the milk produced during the eight feeding regimes were analyzed for significance by Fisher's method of mean squares (3). The analysis shows that there was no significant difference between the scores of the individual judges since $F = 2.04$, which is less than the value of 3.07 required for significance according to Snedecor's tables (4). The value of mean squares between feeding regimes of 7.00 is highly significant since $F = 3.66$ for significance (4). This corresponds to Fisher's 1 per cent point. From this analysis it is concluded that the differences between the feeding regimes as measured by the average flavor scores were real and hence can be used in evaluating the effect of the different feeding regimes on the flavor of milk produced.

TABLE 2

Average milk flavor scores of the four judges

TREATMENT	JUDGES				AVERAGE SCORE OF FOUR JUDGES
	A	B	C	D	
1	22.70	22.93	22.83	22.93	22.85
2	22.65	22.85	22.40	22.55	22 61
3	22.56	22.56	22.74	22.74	22 65
4	22.16	22.10	21.90	21.80	21.99
5	22 86	22.62	22.14	22.19	22 45
6	22.58	22.50	21.83	22.00	22.23
7	21.83	22.33	21.58	21.58	21.83
8	22.25	22.50	22.90	22.50	22.55

DISCUSSION

The results reported in the present study indicate that the college herd, when given the opportunity to consume their roughage requirements immediately after milking, did not return to the feed racks later and consume enough feed during the five hour period before milking to seriously affect the flavor of the milk.

Statistical analysis indicates that the differences in the flavor scores of the milk produced on the eight feeding regimes were significant. Regimes 4 and 7 are regarded as being definitely detrimental to the flavor of milk. Feeding regime 6 was also detrimental, but it was not as objectionable as when the larger quantity of corn silage was fed. The other feeding regimes are considered satisfactory as a practical feeding procedure to minimize the influence of feed on the flavor of milk.

It is to be emphasized that if sufficient quantities of flavor-producing feeds are consumed by cows within four or five hours prior to milking, feed flavor will be present in the milk. The feeding regimes that did not affect the flavor seriously were arranged so that the cows consumed the greater part of their roughage requirements during the first hours after milking.

SUMMARY AND CONCLUSIONS

A herd of nineteen cows was maintained on eight different feeding regimes and the milk produced during these periods was scored by four judges. The following conclusions are drawn:

1. When the cows were receiving alfalfa hay as roughage and were given the opportunity of consuming their roughage requirements immediately after milking, they did not return to the feed racks and consume sufficient hay in the five hour period before milking to seriously affect the flavor of the milk.

2. When the cows were given access to alfalfa pasture both day and night for the entire interval between milkings they did not consume sufficient feed during the last five hours before milking to seriously affect the flavor of the milk. When they were given access to the pasture only during the interval between the morning and evening milkings, they consumed sufficient feed during the five hour interval before milking to cause an objectionable feed flavor in the milk. Under these conditions it is recommended that the cows be removed from the pasture four or five hours before milking if feed flavor in the milk is to be entirely avoided.

3. Pasturing the cows on Sudan grass during the interval between the morning and evening milkings, did not cause an objectionable flavor in the milk.

4. Corn silage in an average amount of 18.9 pounds per cow, fed previous to milking, caused a distinct and undesirable feed flavor in the milk. An average of 14.2 pounds per cow was less detrimental to the flavor but was considered objectionable. If large amounts of corn silage are used in the ration it is recommended that it be fed after milking.

5. When the results were subjected to statistical analysis no significant difference was found between the scores of the different judges. The differences in the regimes were found to be highly significant and corresponded to Fisher's 1 per cent point.

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THE ACCURACY OF THE DIRECT MICROSCOPIC (BREED) COUNT
OF BACTERIA AND LEUCOCYTES IN MILK

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INTRODUCTION

For many years the dairy bacteriologist has been attempting to evaluate the methods in use for the quantitative estimation of bacterial populations in milk. To this end a considerable body of data is now available showing the variability of the plate count and to some extent the relation of the plate count to other methods of analysis. Notwithstanding this, it is not yet possible to estimate with reasonable precision the accuracy of any present method.

Although it is frequently conceded that, except when applied to milk of very low bacterial content, the direct microscopic or Breed count offers the maximum accuracy, no such body of data relative to the accuracy of this test as in the case of the plate count has appeared (2, 3, 4). The present discussion is, therefore, not untimely.

Because of the recent remarkable advances in the technique of sanitary milk production market milks are tending more and more to approach milks aseptically drawn. Any method to be intelligently used for the enumeration of the bacteria in raw market milk should be viewed in the light of this improvement. Therefore, in the present study only milks drawn aseptically from the udder were placed under observation. It is a general belief that the Breed count is least accurate when applied to this type of milk and the inaccuracies are assumed to be due to:

1. The non-representativeness of the small portion of milk examined.
2. The failure of some bacteria to stain.
3. The non-recognition of stained particles as bacteria or foreign matter.
4. The personal factor.

Some of these sources of inaccuracy are minimized by extending the microscopic search and this was done in the present study.

Samples of milk were obtained by carefully drawing into sterile flasks or test tubes an approximately equal amount of milk from each half-empty udder which had previously been wiped with a chlorine solution. The maximum time elapsing between the drawing of the milk and the preparation of the smears was three hours, the usual time being not over one hour and a half.

Standard Methods of Milk Analysis (1) was followed and the Breed factor for the microscope was almost exactly 600,000. For the sake of accuracy a hand tally was used in counting which was done within a circular eye-piece micrometer delineating the central flat portion of the field. Nowithstanding this, considerable focusing was found necessary for the proper identification of many bacterial cells. Care was taken to minimize the overlapping of fields. The preparation of the smears and the counting was all done by one worker (S) and all counts are reported on a per cc. basis. All cells other than those of microorganisms are classed as leucocytes and the possibility of the presence of unstained and, therefore, uncountable leucocytes and bacteria in the milk is disregarded.

The Accuracy of the Microscopic Count of Bacteria in Milk

In 9 (40.4 per cent) of the 22 milks reported in Table 1 no bacteria were observed in the first 60 fields examined, while in 4 (18.1 per cent) over 100 fields were examined before any bacteria were found. The counts based on the examination of 60 fields were larger than the counts based on 1000 fields in the case of 4 (18.1 per cent) miks. The counts based on 1000 fields were greater than the counts based on 2000 fields in the case of 1 (11.1 per cent) of 9 milks. There is no tendency for these exceptions to occur only in milks containing bacteria in large clumps. Two possible explanations are the failure to recognize bacteria occurring singly and the uneven distribution of such organisms.

No bacteria were observed in the first 60 fields of any milk having a 1000 field count of 35,000 or less. This, of course, is due to chance but the chance undoubtedly approaches certainty as the bacterial content decreases. It does not necessarily follow that the 2000 field counts are the most accurate but they are probably so in most cases because the influence of the exceptional clump is lessened as the number of examined fields decreases.

It is apparent from these data that bacteria are very unevenly distributed in this class of milk even when clumping is not extensive. So true is this that the 60 field counts were usually misleading and the 1000 field counts frequently so.

TABLE 1
Breed counts of 22 milks based on the examination of 60, 1000 and 2000 fields per smear

MILK NO.	BREED COUNTS			FIRST FIELD SHOWING BACTERIA	LARGEST GROUP WAS FOUND IN FIELD NO.	CELLS IN LARGEST GROUP
	60 fields	1000 fields	2000 fields			
1	80,000	363,000		11	814	232
2	10,000	35,000		83	832	8
3	10,000	107,400		75	75	97
4	10,000	50,400		69	967	6
5	40,000	121,200		4	87	60
6	10,000	9,000		110	929	2
7	10,000	99,600		31	886	36
8	10,000	7,200		189	882	2
9	10,000	12,000		69	253	10
10	10,000	15,600		120	120	6
11	10,000	18,000		115	312	2
12	90,000	158,400		18	104	150
13	10,000	7,800		98	281	2
14	10,000	39,600	139,800	57	1252	148
15	370,000	48,600	34,800	47	47	14
16	30,000	64,800	147,800	30	1620	250
17	90,000	63,600	119,700	16	1114	34
18	90,000	81,600	200,700	29	1754	350
19	170,000	115,200	477,000	3	1093	200
20	70,000	138,000	142,400	32	65	24
21	60,000	120,000	146,400	57	1050	58
22	20,000	64,000	132,800	30	1267	150

To further study the uneven distribution of bacteria in milk and its effect on the Breed count 8 replicate smears were prepared from each of 2 milks. During the preparation of these smears the milk was gently agitated and the same pipette was used throughout, being thoroughly cleaned and

TABLE 2
The 6000-field (entire smear) bacterial counts of 2 milks, 8 replicate smears of each milk being examined

SMEAR NUMBER	MILK 23			MILK 24		
	Largest group	Group counts	Individual counts	Largest group	Group counts	Individual counts
1	2 cells	8,400	9,300	28 cells	17,900	25,400
2	16 cells	10,800	13,200	18 cells	29,000	38,500
3	200 cells	9,200	30,600	50 cells	23,400	53,500
4	22 cells	9,200	12,900	8 cells	21,600	28,600
5	60 cells	8,400	17,600	6 cells	32,600	38,600
6	4 cells	10,600	12,600	50 cells	41,500	60,100
7	4 cells	8,800	12,800	6 cells	37,300	44,800
8	10 cells	8,100	10,400	10 cells	42,200	46,400
Mean		9,187.5	14,925		30,687.5	41,987.5
Percentage maximum deviation from the mean		17.55	105.02		41.63	43.11
Ratio lowest to highest count		1:1.33	1:3.29		1:2.35	1·2.36
Average percentage absolute deviation from the mean		6.93	30.73		25.13	21.93

dried after each discharge. Each smear was examined in its entirety. Thus, each represents 6000 microscopic fields and, therefore, a total of 48,000 fields per milk was observed. From the results, which are presented in Table 2, it will be observed that the average absolute deviation from the mean of the group count is only 6.93 per cent for the first milk while it is 25.13 per cent for the second. On the other hand the same constants for the individual counts are 30.73 per cent and 21.93 per cent respectively. The uniformity of the group counts in milk 23 is remarkable.

Breed and Brew (2) reported 2 per cent as the maximum deviation from the mean for the accuracy of the Breed pipette in measuring samples of milk for the Breed smear, weight of the delivered sample being the criterion of accuracy. The variability shown in Table 2 is, therefore, likely to be due in the main to the uneven distribution of the bacteria in the milk. It is apparent that 0.01 cc. of this class of milk cannot be depended upon as being representative enough to secure a high degree of accuracy, so unevenly are the bacteria distributed.

The Accuracy of the Leucocyte Count

Prescott and Breed (4) made 31 leucocyte counts in duplicate, each count being based on the leucocytes observed in 100 microscopic fields, and found an average variation of 14.5 per cent. The variations in 2 milks containing less than 250,000 leucocytes per cc. were 42.9 per cent and 64.3 per cent.

It is to be expected that the leucocyte count is more accurate than the

TABLE 3

The 60-field leucocyte counts of 4 milks, a number of replicate smears of each milk being examined

SMEAR NUMBER	MILK 25	MILK 26	MILK 27	MILK 28
1	3,210,000	880,000	140,000	890,000
2	3,270,000	1,000,000	130,000	620,000
3	2,250,000	950,000	120,000	710,000
4	2,570,000	910,000	160,000	800,000
5	3,690,000	770,000	100,000	680,000
6	3,335,000	890,000	160,000	540,000
7	3,160,000	760,000	170,000	710,000
8	2,520,000	600,000	130,000	580,000
9	3,140,000	1,050,000	150,000	480,000
10	2,360.000		120,000	750,000
11			110,000	470,000
12			130,000	450,000
13				550,000
Mean	2,950,500	867,888	135,000	626,923
Percentage maximum deviation from the mean	25.05	30.85	25.70	42.07
Ratio lowest to highest count	1 : 1.64	1 : 1.75	1 : 1.70	1 : 1.97
Average percentage absolute deviation from the mean	13.90	12.11	12.96	17.14

TABLE 4

The 60-field leucocyte counts of 7 milks, a total of 120 fields of each smear being examined

COUNT NUMBER	MILK 29	MILK 30	MILK 31	MILK 32	MILK 33	MILK 34	MILK 35
1	580,000	4,230,000	370,000	100,000	4,730,000	740,000	1,560,000
2	1,130,000	3,070,000	220,000	120,000	5,810,000	750,000	1,730,000
3	1,270,000	3,100,000	340,000	60,000	5,780,000	740,000	1,900,000
4	1,290,000	3,430,000	390,000	50,000	6,590,000	1,030,000	2,120,000
5	1,510,000	4,010,000	310,000	80,000	4,910,000	810,000	2,150,000
6	1,360,000	4,630,000	280,000	130,000	5,780,000	1,060,000	1,850,000
7	1,430,000	3,980,000	300,000	90,000	5,090,000	700,000	1,700,000
8	650,000	3,390,000	250,000	50,000	4,910,000	780,000	1,580,000
9	1,160,000	4,170,000	430,000	60,000	4,440,000	540,000	1,480,000
10	1,480,000	4,260,000	340,000	50,000	4,080,000	770,000	1,600,000
11	1,600,000	4,060,000	300,000	60,000	4,600,000	730,000	1,830,000
12	1,400,000	3,820,000	340,000	80,000	4,700,000	770,000	1,790,000
Mean	1,238,333	3,845,850	322,500	77,500	5,116,666	783,333	1,774,166
Percentage maximum deviation from the mean	53.17	22.80	33.33	67.74	28.54	35.32	21.18
Ratio lowest to highest count	1:2.75	1:1.50	1:1.95	1:2.60	1:1.61	1:1.98	1:1.45
Average percentage absolute deviation from the mean	19.29	10.29	14.21	29.03	11.34	11.48	9.34

Breed count of bacteria since ·leucocytes are larger and more easily recognized than bacteria.

In Table 3 the leucocyte counts of 4 milks are computed from the examination of 60 fields of each of a number of replicate smears. The maximum deviation from the mean ranges from approximately 25 per cent to approximately 42 per cent. The average absolute deviation from the mean is approximately 14 per cent, ranging from 12.11 per cent to 17.14 per cent, and the ratios of the lowest to the highest counts range from 1 : 1.64 to 1 : 1.97.

The question arises whether this variability is caused by the non-representativeness of the smear itself or of the small area of each smear which came under observation. This question is answered by a study of Table 4 in which 720 fields of each of 7 milks were examined and leucocyte counts computed for each 60 fields in the order of examination. The maximum deviation from the mean is seen to range from approximately 21 per cent to approximately 68 per cent and the average absolute deviation from the mean from 9.34 per cent to 29.03 per cent, averaging approximately 15 per cent. The ratios of the lowest to the highest counts range from 1 : 1.45 to 1 : 2.75. Therefore, the variability of the leucocyte count is due in the main to the uneven distribution of the cells in the smear while the smear itself is reasonably representative. There is no consistent tendency for greater variability of count as the leucocyte content decreases.

The extreme ratio of the lowest to the highest count is 1 : 2.75, while the average for the 11 milks is 1 : 1.9. If these figures are representative for usual milk supplies, the 60 field leucocyte count can be depended upon on the average to vary not more than ± 50 per cent from the mean and rarely will the highest count be greater than 3 times the lowest count of replicate samples. On the basis of these data we judge the 60 field leucocyte count to be much more accurate than the Breed count of bacteria in good milk unless the latter is based on the examination of more microscopic fields than is possible in practice.

DISCUSSION

Attempts to determine the accuracy of methods of counting bacteria in milk have included studies of variability and comparisons with other quantitative measures. Variability is not necessarily a true or adequate measure of accuracy. Comparison with another criterion is of limited value unless the criterion itself is accurately evaluated. The most accurate criterion is assumed by some to be the direct microscopic count if a representative portion of milk is examined. If this is true, there is no adequate criterion for determining the accuracy of the Breed count even when it is extensive enough to assure examination of representative portions of the milk. In an investigation of this test a study of variability, despite its inadequacy, seems to be the only available method of approach.

Forty-eight thousand microscopic fields of each of two milks were examined and the results reported in Table 2. To the best of our knowledge this is the most extensive microscopic search to which any milk to date has been subjected. It is thought that the results with these two milks serve as a check on the uniformity with which bacteria were recognized and identified in this study. There is probably little difficulty in identifying with certainty bacterial clumps, while organisms occurring singly are more likely to be overlooked. When a few fields are counted there may be a tendency, of which the microscopist may or may not be conscious, toward duplication of counts because of recollection of numbers. There is evidence in the literature for this being an important factor. When 6000 fields per smear are counted and the numbers recorded mechanically rather than mentally, this tendency toward automatic duplication would appear to be minimized. Therefore, the reported uniformity of dispersion of groups in milk 23 and lack of like uniformity in milk 24 probably approaches the actual condition of the bacteria in these milks. The writers see no reason for supposing that the personal factor differed in the examination of these two milks and it is possible that the reported lack of uniformity in the counts of individuals in each milk and in the group counts of milk 24 is evidence of considerable accuracy in the identification and counting in this study. The exact counting of the bacteria in a large clump is, of course, difficult. It is believed that the maximum inaccuracy introduced by this factor in the present study is not greater than 100 per cent.

Working with aseptically-drawn milk it was amply demonstrated that the milk observed in the examination of 60 fields was seldom reasonably representative of the sample from it came even when the bacterial content of the milk was rather high for such milk. The examination of 1000 fields sometimes gave misleading results. Indeed, in milks of low bacterial content 0.01 cc. cannot be depended upon as being truly representative. As milk improvement is effected the usefulness of this test as a precise quantitative measure decreases unless more fields are examined than seems possible in routine work. The writers are of the opinion that in the reporting of research a statement of the Breed count should always be accompanied by a citation of the number of examined fields unless the bacterial content of the milk is high. These results are in general accord with those reported by others for milk of low bacterial content (3, 5).

CONCLUSIONS

1. The high/low ratio of replicate 60 field direct microscopic leucocyte counts from Breed smears may be expected to be not greater than 3/1. This variation is interpreted as indicating reasonable accuracy in this method of counting leucocytes in milk.

2. The high/low ratio of the 60, 1000 and, in a few cases, 2000 field

direct microscopic counts of bacteria from the same sample was greater than 4/1 in 16 (72.7 per cent) and greater than 8/1 in 12 (54.5 per cent) of 22 milks of low bacterial content. This variation is interpreted as indicating that the 60 field direct microscopic count is not reasonably accurate as a precise estimate of the number of bacteria in this class of milk.

3. The high/low ratio of replicate 6000 field direct microscopic counts were 3.29/1 and 2.36/1 for two milks of low bacterial content. The interpretation is made that 0.01 cc. may not constitute a representative sample for the precise estimation of bacterial numbers in this class of milk.

4. The number of fields on which the direct microscopic count of bacterial numbers in milk is based should always be reported unless the milk is high in bacterial content.

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A COMPARISON OF THE STANDARD WITH THE MODIFIED METHYLENE BLUE REDUCTION TECHNIC

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INTRODUCTION

Since the first use of dye reduction as an indicator of bacterial action in milk (2, 5) general milk supplies on this continent have undergone remarkable improvement. Many of the earlier studies of the methylene blue reduction test were largely concerned with a class of milk which is today rapidly disappearing from the market.

With the gradual elimination of the poorer classes of milk from the fluid milk market the inaccuracies of the methylene blue reduction test evoke greater interest than heretofore. Attention has recently been focused on this subject by the acceptance of the recommendation of Wilson (12) that a modified methylene blue reduction technic be adopted as standard in England.

One of the outstanding advantages of the methylene blue reduction test is that, while the interpretation of results should be made only with an adequate knowledge of the available information regarding the test, the technic of operation may demand a less exact training than either the agar plate or microscopic counts. For this reason the methylene blue reduction test has been useful in many situations where otherwise bacteriological control of the milk supply would be difficult or impossible.

The modification proposed by Wilson complicates the operation of the test to the extent that strictly uniform technic would be improbable in the hands of some who are at present satisfactorily performing the test. Therefore, any extensive complication of the technic should be adopted as standard on this continent only on the presentation of proof that the modification compensates with greater accuracy.

HISTORICAL

In 1913 Skar (6), while studying the reduction of methylene blue by milk leucocytes, observed irregular disappearance of the dye from some samples of milk. He introduced a shaking technic which resulted in decreased reduction times of unreported magnitude. He concluded that bacteria and leucocytes are carried into the cream layer by the rising butterfat or collect by the force of gravity, or otherwise, at the bottom of the tube. The cells so situated would have, therefore, little or no effect upon the reduction time in the main body of the milk.

Thornton and Hastings (9, 10) observed serious variations in the reduction times of replicate tubes of many milks, these variations tending to increase with the reduction times. The variation in dye reduction in different portions of the same tube as well as the variations in reduction times in replicate tubes disappeared almost completely and reduction times were shortened, particularly in the case of long-time reducing milks, when the tubes were shaken during incubation. They obtained the same results whenever the butterfat was prevented from rising whether by agitation, lack of space, rennet or agar coagulation or by homogenization. Violent, prolonged or frequent shaking gave approximately the same results as ordinary shaking. They concluded that in the standard technic butterfat rising in the unagitated milk sweeps bacteria into the cream layer, a larger proportion being so swept out of good than of poor milk. This, the authors believe, is a cause of variation and inaccuracy in the reduction test and the interpretation was made that this test should not be considered reasonably accurate after the 5½-hour period.

Johns (4) introduced a "modified" methylene blue reduction test, the modification being:

(a) Preliminary incubation at 55° F. (12.8° C.) for 18 hours, and
(b) Mixing contents of tubes not decolorized in 6 hours when subsequently incubated at blood heat.

The author commented that "the chief advantages of the modified test are. (1) greater convenience to the analyst, (2) improved accuracy on high grade milks and (3) closer correlation with keeping quality."

In 1934 Thornton et al. (11) reported that "The standard methylene blue reduction test was supplemented in almost all cases by a modified test. The modification consisted of shaking the tubes every half-hour during incubation in the constant-temperature water-bath which was maintained at 37° C. ± ½°. This technique has the effect of shortening the reduction times of the majority of milks of the class under discussion in this paper and, we believe, gives more nearly accurate results than the standard technique."

Wilson (12) recommended the adoption in England of a modified methylene blue reduction test, the modifications being inversion of the tubes once every half-hour during incubation, which is conducted in the dark. He agrees that the sweeping action of the rising butterfat is a cause of variation in the test and believes that the butterfat itself, "or some substance adherent to it," plays a part in the mechanism of reduction.

DEFINITION OF TERMS

In the present paper the standard methylene blue reduction test of the A.P.H.A. (1) will be referred to as the methylene blue reduction test while the modified methylene blue reduction test will mean one inversion of the

tubes of milk each half-hour during incubation with no consideration of the effect of light on reduction. Reduction times are reported in hours and minutes, 8:30 meaning 8 hours and 30 minutes.

THE SOURCES OF INACCURACY IN THE REDUCTION TEST

There are probably a number of sources of inaccuracy in the methylene blue reduction test, some perhaps still unrecognized. Of the recognized sources at least three appear to be important.

The first is dependent on the well-known fact that some living bacteria which occur in milk may be unable to grow in this medium at 37° C. What definite relation this bears to the accuracy of the methylene blue reduction test is not known.

The second source of inaccuracy depends on the varying influence of different species of bacteria which grow in milk at 37° C. on oxidation-reduction potential drifts. This is assumed to vary with the oxygen consumption rates of the bacteria and the extent of inaccuracy thus introduced into the test is not known.

The third important source of inaccuracy is the sweeping of bacteria out of the milk by the rising butterfat. An essential departure from the standard technic demanded by the three modifications mentioned above is in the nature of an effort to eliminate or control this factor.

Thornton and Hastings believed the methylene blue reduction test not to be reasonably accurate after the 5½ hour period, an opinion with which Wilson seems to concur. Johns on the other hand believes the test to be reasonably accurate up to 10 hours, basing his estimate of accuracy on variability in replicate tubes. Thornton and Hastings used decreased reduction times due to shaking as well as variability in replicate tubes as their criteria of accuracy. Thornton *et al.* (11) present evidence that, despite its inaccuracy when used on better class milks, the methylene blue reduction test is still more accurate for many of these milks than is the plate count. If this is a sound conclusion, then it is probable that the reduction test will continue to be used for good milks until a more accurate test is available. Nevertheless, it is questionable if intelligent interpretation can at present be made of standard reduction time differences in milks reducing beyond 10 hours.

VARIABILITY IN REPLICATE SAMPLES

Thornton and Hastings (10) report rather startling variations of reduction times in replicate tubes for a few samples of milk but fail to indicate the extent of such variations for 95 other milks. These variations recalculated from their data are here presented in Table 1 and are not essentially different from the variations reported by Johns (4).

The average generation time during the reduction test of commercial

TABLE 1

Relation between reduction time and variability

(Recalculated from data of Thornton and Hastings on 95 samples.)

CLASS INTERVAL IN HOURS	NUMBER OF SAMPLES	NUMBER OF SAMPLES SHOWING VARIATION IN DUPLICATE TUBES	MAXIMUM VARIATION	AVERAGE VARIATION
0– 1	11	0	0:00	0:00
1– 2	11	2	0:35	0:05
2– 3	7	0	0:00	0:00
3– 4	11	1	0:25	0:03
4– 5	10	1	0:50	0:05
5– 6	9	0	0:00	0:00
6– 7	8	1	0:15	0:02
7– 8	10	3	0:40	0:06
8– 9	8	4	0:45	0:13
9–10	5	5	0:45	0:30
10–12	5	5	0:30	1:01

milks is not known. The average generation times in the case of 25 aseptically-drawn milks were found in this laboratory to vary from 29 to 74 minutes, averaging 54 minutes. If we assume a generation time of 1 hour in the reduction test then a variation of 1 hour represents 100 per cent variation in the bacterial numbers of the original milk, irrespective of the reduction time. 'It is seen that not only does the inaccuracy of the reduction test increase with increasing reduction times but the inaccuracy due to this factor alone is a serious one.

Ellenberger *et al.* (3) and Wilson (12) concluded that the methylene blue reduction test is many times less variable than the plate count but failed to take cognizance of the fact that the variability displayed by the one method cannot be directly compared with that exhibited by the other because of logarithmic relations in the methylene blue test and linear relations in the plate count. Wilson's statement that the modified reduction test is 20 times less variable than the plate count becomes misleading in view of the method by which this figure was obtained. A coefficient of variability of 1.12 per cent of the mean reduction time, 235 minutes, is a standard deviation of 2.63 minutes. If a variation of 60 minutes in the reduction time represents 100 per cent variation in the bacterial content of the original milk and if the bacterial content and the plate count are assumed to be identical, then a variation of 2.63 minutes in the reduction test represents approximately 4.4 per cent variation in the plate count. With these assumptions the comparable figures are 4.4 per cent and 21.45 per cent which Wilson reported as the coefficient of variability of the plate count. In these terms the modified reduction test is approximately 5 times less variable than the plate count.

When calculated in a similar manner the methylene blue reduction test coefficient of variability of 4.47 per cent as reported by Ellenberger *et al.* (3, Series I, Table 5) is the equivalent of 58 per cent variation in the plate

count which is almost exactly double the coefficient of variability (29.02 per cent) of the plate counts of the same 79 samples of milk. Their statement that "the methylene blue reduction test shows much less (one-seventh as much) variability between check or duplicate tests than does the agar plate method" should be accepted with considerable reservation.

REDUCTION TIME DIFFERENCES DUE TO SHAKING

Table 2 presents average reduction time differences due to shaking for 335 market milks. It is seen that the modified technic results on the average

TABLE 2

Relation between standard and modified reduction times of 335 market milks

CLASS INTERVAL IN HOURS	NUMBER OF SAMPLES	AVERAGE STANDARD REDUCTION TIME	AVERAGE MODIFIED REDUCTION TIME	DIFFERENCE DUE TO SHAKING
0- 1	11	0 : 30		+ 0 : 09
1- 2	17	1 : 20	: 17	− 0 : 03
2- 3	10	2 : 20	2 : 08	− 0 : 12
3- 4	15	3 : 25	2 : 47	− 0 : 38
4- 5	24	4 : 23	3 : 29	− 0 : 54
5- 6	27	5 : 24	4 : 11	− 1 : 13
6- 7	29	6 : 23	5 : 07	− 1 : 16
7- 8	35	7 : 18	5 : 50	− 1 : 28
8- 9	28	8 : 24	6 : 11	− 2 : 13
9-10	18	9 : 25	6 : 52	− 2 : 33
10-11	29	10 : 17		− 3 : 04
11-12	28	11 : 26		− 4 : 36
12-13	31	12 : 27	7 : 38	− 4 : 49
13-14	13	13 : 17	7 : 49	− 5 : 28
14-15	9	14 : 10	8 : 21	− 5 : 49
15-16	8	15 : 30	9 : 39	− 5 : 51
16-17	1	16 : 00	9 : 00	− 7 : 00
17-18	1	17 : 00	7 : 00	− 10 : 00
23-24	1		8 : 00	− 15 : 00

in little difference up to 2-3 hours and may even cause an increased reduction time in some of these milks due to the incorporation of oxygen just prior to reduction of the dye. In the medium and better class milks there is a material decrease in average reduction time due to the inversion of the tubes. These results check very closely with those of Johns and Wilson. If the modified test is substituted for the standard test it appears sound to use the following equivalents:

Standard reduction time	*Modified reduction time*
8 : 00	6 : 00
5 : 30	4 : 00
2 : 00	2 : 00

A total of 6 better class market milks in some hundreds of samples have been observed by the writer to have longer modified than standard reduction times (Table 3). The difference in the case of milk 3 is probably due to

shaking when the end-point was almost reached. At least 3 of the samples were found to contain mastitis milk. No information was available for

TABLE 3

Increased reduction times due to shaking 6 market milks reacting abnormally

MILK NUMBER	STANDARD REDUCTION TIME	MODIFIED REDUCTION TIME	INCREASE DUE TO SHAKING
1	4:30	8:00	3:30
2	5:15	7:30	2:15
3	5:20	5:45	0:25
4	6:00	8:00	2:00
5	6:00	8:30	2:30
6	6:30	8:00	1:30

the 2 remaining milks to permit of interpretation.

As milk supplies on this continent improve they are gradually approaching mixed aseptically-drawn milks. The effect of shaking such milks during the reduction test is, therefore, of importance. Table 4 contains data on

TABLE 4

The effect of shaking 95 aseptically-drawn udder milks

CLASS INTERVAL IN HOURS	NUMBER OF SAMPLES	AVERAGE STANDARD REDUCTION TIME	AVERAGE MODIFIED REDUCTION TIME	AVERAGE DIFFERENCE
0– 1	4	0:40	0:40	0:00
1– 2	2	1:45	1:50	+ 0:10
2– 3	1	2:10	2:15	+ 0:05
3– 4	4	3:22	2:53	− 0:29
5– 6	2	5:00	6:00	+ 1:00
6– 7	1	6:15	14:45	+ 8:30
7– 8	1	7:00	6:30	− 0:30
8– 9	5	8:27	6:27	− 2:00
9–10	5	9:24	7:22	− 2:02
10–11	5	10:14	8:45	− 1:29
11–12	4	11:25	9:30	− 1:55
12–13	3	12:35	10:08	− 2:27
over 13	58	over 13:00	10:46	over − 3:00

95 samples drawn aseptically from the udder, the sample being a composite from each milking quarter of a cow. The milks reported in Table 5 were aseptically drawn from each milking quarter of 27 cows on each of three mornings within one week, the milk from each quarter being tested separately. Strynadka, from whose work these data were taken (7), showed that when the shaking technic results in a considerably prolonged reduction time an abnormal condition of the udder is indicated. The effect of such abnormal milk on the methylene blue reduction test as well as the modified test is lessened as it is mixed with normal milk. It is believed, therefore, that the conclusions reached in this communication regarding the use of the modified test for present market milks will continue to be sound as the milk supply improves.

TABLE 5

The effect of shaking 313 aseptically-drawn milks from the individual quarters of 27 cows

CLASS INTERVALS IN HOURS	NUMBER OF SAMPLES	AVERAGE STANDARD REDUCTION TIME	AVERAGE MODIFIED REDUCTION TIME	AVERAGE DIFFERENCE
0– 1	1	0 : 30	0 : 30	0 : 00
1– 2	3	1 : 10	1 : 55	+ 0 : 45
2– 3	2	2 : 00	1 : 30	– 0 : 30
3– 4	4	3 : 15	3 : 41	+ 0 : 26
4– 5	2	4 : 38	3 : 15	– 1 : 23
5– 6	4	5 : 23	5 : 56	+ 0 : 33
6– 7	6	6 : 25	9 : 28	+ 3 : 03
7– 8	3	7 : 30	4 : 00	– 3 : 30
8– 9	5	8 : 15	7 : 18	– 0 : 57
9–10	2	9 : 15	7 : 30	– 1 : 45
10–11	15	10 : 18	8 : 16	– 2 : 02
11–12	18	11 : 37	8 : 56	– 2 : 41
12–13	21	12 : 26	8 : 56	– 3 : 30
13–14	23	13 : 15	8 : 53	– 4 : 22
14–15	16	14 : 29	9 : 56	– 4 : 33
15–16	22	15 : 23	10 : 12	– 5 : 11
16–17	33	16 : 22	9 : 50	– 6 : 32
17–18	18	17 : 23	9 : 34	– 7 : 46
18–19	15	18 : 03	10 : 20	– 7 : 43
19–20	9	19 : 25	11 : 32	– 7 : 55
20–21	22	20 : 16	10 : 03	– 10 : 13
21–22	13	21 : 23	10 : 38	– 10 : 45
22–23	9	22 : 07	11 : 13	– 10 : 54
23–24	7	23 · 21	11 : 08	– 12 : 13
24–25	20	24 : 06	11 : 54	– 12 : 12
over 25	20	over 25 : 00	11 : 47	– 13 : 13

FACTORS INTRODUCED INTO THE TEST BY THE SHAKING TECHNIC

There appear to be at least three factors introduced into the test by shaking the tubes, viz.:

1. The bacteria are kept more evenly distributed.
2. The butterfat is kept more evenly distributed.
3. More oxygen becomes dissolved in the milk.

The bulk of the evidence supports the theory of Thornton and Hastings that the decrease in reduction time due to shaking is largely attributable to a more even distribution of bacteria.

It has never been proved that the butterfat itself is in no way directly concerned with the reduction of methylene blue in milk. Wilson states that "The effect of the fat is still undetermined, and until it can be obtained in pure condition, freed from all dissolved and adsorbed substances, and emulsified in a legitimate manner, opinion must be reserved on its real action. It appears, however, to have at least three effects. In the first place it probably acts in a purely physical capacity, affording a large surface on which enzyme reactions can occur. In this connection it may be noted that both xanthine oxidase, and the other enzymes of whose existence we have some evidence, are both linked to the fat. Secondly, it has a visual effect, de-

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creasing the depth of colour yielded by a given concentration of methylene blue, and consequently shortening the time to apparent complete reduction of the dye. Thirdly, by adsorbing methylene white, it disturbs the ratio of oxidant to reductant, and so allows complete reduction of methylene blue to occur at a higher Eh than would have been registered in the absence of fat.''

If this opinion is right it is difficult to explain the results of Thornton and Hastings with homogenized milk and would seem to imply a condemnation of the modified reduction test as well as the application of the reduction test to cream. Neither group of workers was able to correlate reduction times and fat contents of market milks. Thornton (8) presented evidence that the sweeping effect of the rising butterfat is related to the creaming properties of the milk, one milk reported by him reducing in 2:30 by the standard technic and in 6:25 when manipulated so as to enhance creaming.

The incorporation of extra oxygen into the milk through shaking has at least a twofold effect as pointed out by Thornton and Hastings. It has a delaying effect inasmuch as the bacteria are required to consume more oxygen. It may also stimulate or retard bacterial growth. Wilson believes the stimulating effect of importance but fails to report by what technic he was able to measure it. His work with 10 and 20 ml. quantities of milk permit of two interpretations, viz.: oxygen effect and enhanced creaming effect. It seems probable that the latter was the more important.

It is highly improbable that the stimulating effect of the added oxygen is a major factor in the modified test because half of the total oxygen consumed during the test is consumed during the last generation period before reduction, assuming constant bacterial growth. In a long-time reducing milk the oxygen pressure is, therefore, very slightly decreased for the larger part of the test. The fact that the modified technic does not often result in shortened reduction times of the poorer milks does not point to stimulation of bacterial growth during the period of rapid fall of potential.

If the incorporation of extra oxygen is effected immediately prior to reduction of the dye, the reduction time is thereby lengthened. Thus care should be exercised in the final inversion of the tube.

FREQUENT VERSUS INFREQUENT SHAKING

Thornton and Hastings found no difference in reduction times when the tubes were shaken gently (2 to 3 times) or violently (25 times) every half-hour, while quarter- and half-hour shakings gave different results only in the case of short-time reducing milks.

Johns observed differences in the case of some milks between shaking every hour and every 3 hours, while shaking every 6 hours gave materially different results.

Wilson reported a mean difference of 8 minutes for 19 samples of Grade A milk when shaken once and 4 times every half-hour. He concludes that "The extra inversion of the second set had thus delayed reduction for about 8 minutes." Since it is probable that this difference is not outside the experimental error even of reading the end-point of reduction for this class of milk, the author's statement hardly seems justifiable. His further results (12, Table CXXVIII) should be interpreted with care for he worked with a small number of samples, the groups were not composed entirely of replicates and the differences between group reduction times were not, in some cases, outside the standard deviations of the differences. By the usual criterion of significance for a small number of samples (Fisher's t) a difference of about 24 minutes would be necessary to be significant.

Data on a few samples of milk subjected to varying shaking technics are presented in Table 6.

TABLE 6

The effect of varying frequency and violence of shaking

MILK NO	NO OF TUBES	STANDARD		INVERTED ONCE AT 4-6-8 HOURS		INVERTED ONCE EACH HALF HOUR	
		Average red. time	Maximum variation	Average red. time	Maximum variation	Average red. time	Maximum variation
1	5	12:30	1:00	8:15	0:00	7:00	0:00
2	5	8:30	0:00	7:00	0:00	6:30	0:00
3	5	13:15	0:30	9:15	0:00	8:00	0:00
4	5	6:45	0:00	5:00	0:00	4:30	0:00
				Violently shaken at 4-6-8 hours			
5	5	11:00	1:00	6:45	0:00	6:00	0:00
6	5	8:15	1:00	5:15	0:00	4:30	0:00
7	5	12:00	1:00	8:45	0:45	7:15	0:00
8	5	8:30	0:45	6:30	0:00	5:45	0:00
				Inverted once each hour			
9	5	8:45	1:15	5:45	0:00	5:30	0:00
10	5	9:45	0:15	6:00	0:00	6:00	0:00
11	5	7:00	0:00	6:15	0:00	6:15	0:00
12	5	7:25	0:15	6:00	0:00	6:00	0:00

The weight of the available evidence is to the effect that inversion of the tubes once per hour gives results differing from inversion once each half-hour, if at all, by an amount that is within the experimental error of reading the end-point. The shaking technic, if used, should be of sufficient force and frequency to prevent the formation of a cream layer or ring difficult to disperse.

THE ACCURACY OF THE MODIFIED TEST

Attempts to determine the accuracy of the methylene blue reduction test have been made by a large number of investigators using various criteria. The most frequently used criteria have been the agar plate count, the keeping

quality of the milk and the variability of the reduction test. Such methods of comparison have not as yet resulted in a proved accuracy for any of the three tests. It is probable that the methylene blue reduction test is at least as accurate as the plate count and more accurate than the keeping quality test as a measure of the numbers of bacteria in raw milk. The determination of the accuracy of one method of measurement by comparison with another method of unknown accuracy appears to be futile.

Some workers are willing to accept the variability of the reduction test or plate count as a complete measure of accuracy. The present writer is of the opinion that variability is a very inadequate measure of the accuracy of the plate count and probably of the reduction test.

Thornton and Hastings (10), Johns (4), Thornton (8), and Wilson (12) have all expressed the belief that the shaking technic results in greater accuracy in the methylene blue reduction test but none has yet substantiated his opinion with acceptable proof or successfully measured the extent of greater accuracy.

The coefficient of correlation between the methylene blue reduction times and the modified reduction times of 332 of the 335 market milks reported in table 4 is 0.94 ± 0.004. This very high correlation means that on the average there can be little difference in the accuracy of the two tests, although the variability displayed by the standard test may lead to inaccuracy in the case of an individual sample.

CONCLUSIONS

This review of the literature and presentation of new data seem to justify the following conclusions:

1. The accuracy of the methylene blue reduction test still awaits determination.

2. Replicate samples of good milks frequently exhibit serious variations of standard reduction times.

3. The variations tend to increase in frequency and magnitude as the reduction time increases.

4. These variations practically disappear if the tubes of milk are shaken during incubation and the reduction times of such milks are usually shortened.

5. The coefficient of correlation between the standard and modified reduction times is so high that there is little, if any, difference in the average accuracies of the two tests despite the variability in individual samples in the standard test.

6. The present evidence does not warrant the replacement as standard of the methylene blue reduction test by the modified methylene blue reduction test, since the possible greater accuracy of the latter is offset by greater complexity of technic.

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THE RESAZURIN TEST—ITS USE AND PRACTICABILITY AS APPLIED TO THE QUALITY CONTROL OF RAW MILK

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An earlier report[1] by Ramsdell, Johnson, and Evans discussed the use of Resazurin as a chemical indicator for determining the sanitary quality of milk. On the basis of the above investigation, it was concluded that the use of Resazurin gave more information as to the quality of milk than any other chemical indicator now in use. Further work on this dye was conducted by C. K. Johns.[2] Coincident with this latter research, investigations on Resazurin were initiated in these laboratories. It is the purpose of this paper to present data which indicate, first, that the Resazurin test is of added value as an indicator of quality over the Methylene Blue test as well as having the advantage of consuming much less time than the latter test, and second, that the Resazurin test is a valuable adjunct to microscopic diagnosis in routine quality control of milk.

EXPERIMENTAL

Of primary interest was a comparison of the sensitivity of Resazurin to that of Methylene Blue, the standard plate method, and the microscopic Breed smear. Accordingly, the producer samples were obtained at the weigh can and all of the above-mentioned tests were run on each milk. The Resazurin test was run according to the following procedure:

1. One tenth of one cc. of 0.05 per cent Resazurin dye solution (Eastman) was measured into a sterile test tube.

2. Milk samples were obtained directly from the weigh can, using a 10 cc. narrow bore-type dipper.

3. Samples were incubated for one hour at 98° F., in a covered water bath.

4. The samples were read and recorded as quickly as possible after the incubation period.

A total of 305 samples were collected for this test over a period of five weeks. Although the determinations were made in unison, they are presented separately for purposes of clarity.

Of the 220 samples remaining blue at the end of one hour of incubation with Resazurin, 201, or 91 per·cent, were incapable of reducing the Methy-

[1] Ramsdell, G. A., Johnson, Jr., W. T., and Evans, F. R. Investigation of Resazurin as an indicator of the sanitary condition of milk. JOUR. DAIRY SCI., 18: 705–717. 1935.

[2] Johns, C. K. Paper presented at meeting of Vermont Dairy Plant Operators and Managers' Association, November 19, 1936.

Comparison of color of Resazurin dye at the end of one hour with reduction time of Methylene Blue

NO. OF SAMPLES	COLOR OF RESAZURIN AFTER 1 HR.	REDUCTION TIME OF METHYLENE BLUE			
		7 hrs. or longer	6 hrs.	5 hrs.	Less than 5 hrs.
220	Blue	201	11	4	4
30	Purple Pink	21	3	1	5
32	Sl. Pink	26	3	1	2
14	Pink	4	2	1	7
7	Vivid Pink	4			3
2	White				2

lene Blue dye in seven hours or more. Purple pink and slight pink color shades, denoting some reduction with the Resazurin dye, did not, in many cases, affect the reduction time of Methylene Blue. This may be accounted for from the fact that staphylococci have a particular aptitude for reducing the Resazurin as compared to other types of bacteria commonly found in milk. Leucocytes encountered in colostral and mastitis-infected milk also cause rapid decolorization. The latter statement was particularly emphasized in the seven samples which were vivid pink on the Resazurin test at the end of one hour. Four of these samples which were unable to decolorize Methylene Blue in seven or more hours had a high leucocyte content. This bespeaks the sensitivity of Resazurin to physiologically abnormal and pathological milks as previously demonstrated.[1]

Comparison of color of Resazurin dye at the end of one hour with standard plate count

NO. OF SAMPLES	COLOR OF RESAZURIN AFTER 1 HR.	STANDARD PLATE COUNT				
		Less than 25,000	25,000 to 50,000	50,000 to 100,000	100,000 to 200,000	Over 200,000
220	Blue	160	32	14	9	5
30	Purple Pink	7	12	3	3	5
32	Sl. Pink	17	10		2	2
14	Pink	8		2	2	2
7	Vivid Pink	4	1			2
2	White	1				1

The standard plate counts on these milks were less than 25,000 bacteria per cubic centimeter (Table 2). With five exceptions, milks incubated with Resazurin which remained unchanged in color at the end of the hour had a standard plate count of less than 200,000 per cc. The similarity in correlation of the purple pink and slight pink shades indicates the desirability of classifying these two colors together. One of the two samples completely reduced on Resazurin to white had a standard plate count of less than 25,000; however, the microscopic count was over 200,000, actually uncountable, as may be seen from Table 4. Again, the effect of staphylococci and high leucocyte milk on the reducing time of the dye was encountered, making

further correlations of this new test with previously known standards rather difficult. As may be seen from Tables 2 and 3 the Resazurin test is comparable to the Methylene Blue test in regard to the standard plate count.

TABLE 3

Comparison of reduction time of Methylene Blue with bacterial plate count

NO. OF SAMPLES	REDUCTION TIME OF METH. BLUE	STANDARD PLATE COUNT				
		Under 25,000	25,000 to 50,000	50,000 to 100,000	100,000 to 200,000	Over 200,000
253	7 hrs.	174	48	13	12	6
19	6 hrs.	6	5	3	3	2
7	5 hrs.	2	1	2		2
23	Under 5 hrs.	4	5	2	3	8

From these results it may be said that data as to the bacterial quality of milk obtained from one hour of incubation with Resazurin are fully as reliable as seven hours' incubation with Methylene Blue. Moreover, Resazurin is more sensitive to physiologically abnormal and pathological milks than is Methylene Blue. The correlation between Resazurin sensitivity and microscopic Breed count is better than that obtained through comparison with the standard plate method, as might be expected, due to the ability of the microscope to diagnose leucocytes, staphylococci, etc.

TABLE 4

Correlation between colors developed after one hour of incubation with Resazurin and microscopic Breed count

NO OF SAMPLES	COLOR OF RESAZURIN AFTER 1 HR.	MICROSCOPIC BREED COUNT				
		Under 25,000	25,000 to 50,000	50,000 to 100,000	100,000 to 200,000	Over 200,000
166	Blue	148	7	9	2	
25	Purple Pink		20	4	1	
32	Sl. Pink		22	3	5	1
11	Pink		7	2	1	1
7	Vivid Pink	4	1		1	1
2	White*					2

* High leucocytes.

It, therefore, cannot be stated that an accurate or semi-accurate bacteria count can be obtained from Resazurin because it is very sensitive to milk that is abnormal from causes other than bacteria count. Yet, the very sensitivity of Resazurin to these other quality defects in milk should be characterized as an asset.

If reliance were placed on the classification of milk according to the variour color shades of Resazurin formed at the end of the hour of incubation considerable discrepancy between laboratories could be expected unless color standards were used. Microscopic diagnosis of all samples showing partial or complete reduction therefore seemed desirable. Moreover, in many plants

microscopic examination of individual producers' milk constitutes a great portion of the time spent in laboratory control. A preliminary test which would be capable of segregating those milks which are satisfactory from those which are not, prior to microscopic diagnosis, would place emphasis on poor milks and also save a considerable amount of time.

THE RESAZURIN TEST AS A PRELIMINARY TEST FOR MICROSCOPIC DIAGNOSIS

All producers' samples were incubated with Resazurin for one hour. At the termination of this period the samples were examined and Breed smears were made directly from those tubes in which the dye was partially or completely reduced. This method was adopted inasmuch as it obviates the necessity of double samples and since we were more interested in determining the types of bacteria rather than the total number of bacteria. The slight growth obtained during the incubation period was of value particularly in those cases where *Streptococcus agalactiae* was the cause of reduction. The practical application of this procedure is demonstrated in Table 5, a duplication of a test sheet from one of our country stations. This table represents the number of samples examined out of 100 producer samples taken.

TABLE 5

Microscopic examination of milk found positive to Resazurin test

PRODUCER NUMBER	COLOR OF RESAZURIN AFTER 1 HR. INCUBATION	MICROSCOPIC DIAGNOSIS	REMARKS
5	Slight Pink	120,000 bact. per cc. 900,000 " " "	Utensil bacteria
8	Vivid Pink		Utensil and lactic bacteria types
14	White	Uncountable	Spore formers and lactics. Check immediately
20	Purple Pink	25,000 bact. per cc. 1,500,000 leucocytes "	
21	Purple Pink	50,000 bact. per cc.	Utensil and lactics
38	Pink	25,000 " " " 4,000,000 leuco. " "	Mononuclear types. Hold out milk from fresh cows
59	Vivid Pink	Mastitis	Reject milk until cleared up. Check herd
62	Purple Pink	250,000 bact. per cc.	Utensil and lactics
70	Purple Pink	O. K.	
76	White	Uncountable	External contamination combined with dirty utensils and poor cooling. Check immediately
80	Purple Pink	30,000 bact. per cc. 2,000,000 leuco. " "	Staphylococci. Check milking machine in particular
87	Purple Pink	O. K.	
90	Pink	O. K.	
96	Vivid Pink	600,000 bact. per cc. 3,000,000 leuco. " "	Lactics

In most cases where there was a color change, as in the above table, poor quality was verified by the microscope. Occasionally samples will change

to a purplish pink and may even turn pink, yet under the microscope no abnormality is observed. The cause of this has not as yet been entirely determined. However, previous investigations[1] state that the Resazurin dye is reduced more rapidly by milk with a high catalase and chloride content and these factors may be responsible.

As may be observed from Table 5, the time saved through the use of the Resazurin-microscope combined procedure was equivalent to the time necessary to smear, diagnose and wash up the slides for 86 microscopic samples.

An approximation of the amount of time saved in our other country laboratories is given in Table 6.

TABLE 6

STATION	NO. OF SAMPLES TAKEN IN 1 WK.	MICROSCOPIC ANALYSES MADE 1 WEEK	ESTIMATED TIME SAVED 1 WEEK
A	475	75	13 hrs.
B	600	100	16 hrs.
C	260	40	6 hrs.
D	400	60	11 hrs.
E	365	55	10½ hrs.
F	260	40	6 hrs.
G	240	35	5½ hrs.
H	120	20	2 hrs.

Thus, the introduction and use of the procedure in our country laboratories has given us quicker segregation of poor quality milk, placed more emphasis on poor quality milk, allowed more time for follow-up and, because of this, increased the frequency with which the tests can be run. For these reasons the combined Resazurin-microscopic diagnosis seems to be of singular aid in a general quality improvement program.

These preliminary thoughts on the use and practicability of Resazurin are presented that they might stimulate further discussions and research on a test which warrants further investigation.

CONCLUSIONS

1. Information as to the sanitary quality of milk can be obtained in one hour through the use of the Resazurin test which is comparable to that obtained in seven hours using the Methylene Blue test.

2. The Resazurin test is superior to the Methylene Blue test in that it is extremely sensitive to physiologically abnormal and pathological milks.

3. The Resazurin test is a valuable adjunct to microscopic diagnosis in eliminating the time normally spent in diagnosis of good milks, thereby allowing more time for detection of the source of the trouble with poor milks.

ACKNOWLEDGMENTS

THE DETECTION OF SHEDDERS OF THE STREPTOCOCCUS OF MASTITIS IN COMPOSITE CONTROL MILK SAMPLES[1]

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In the examination of milk samples for the purpose of control, high cell counts and streptococci indicate that routine dairy inspection, including physical examination of animals and chemical tests (1) on the milk, does not detect all shedders of the streptococcus of mastitis. It has been shown by the most recent investigators (Bryan (2), Hucker and Hansen (3), Minett (4), and Plastridge, Anderson, Brigham and Spaulding (5)) that about 90 per cent of the strains causing infectious bovine mastitis belong to a well-defined group to which the specific name *Streptococcus agalactiae* has been given.

While the characteristics of *Streptococcus agalactiae* (6) are well known, it is sometimes difficult for the laboratory, using as samples milk from individual cows, to do the work necessary to its identification. The purpose of this paper is to describe a routine procedure which can be carried out in a public health laboratory, using composite producer-control samples, and to demonstrate that the quality of the milk supply can be improved by the application of this procedure and consequent elimination of infected individuals in the herd.

Direct microscopic tests have been described in which the finding of long-chained streptococci in aseptically-drawn individual samples were thought to indicate the existence of an infection (1, 2). Our findings are not in agreement with those findings since saprophytic streptococci have been isolated repeatedly from aseptically-drawn individual samples and *Streptococcus agalactiae* has been found in samples in which no streptococci were seen in smears from either unincubated or incubated samples.

A satisfactory method for the detection of animals infected with mastitis should include, not only the demonstration of the presence of streptococci in the udder secretions, but also the identification of the type or types found. Although we realize the importance of high cell counts in individual cow samples, we do not believe they have the same significance when made from composite herd samples. However, in many instances we recorded very high cell counts from the composite samples and took this to indicate the possible existence of mastitis infection in the herd. Since both the finding of long-chained streptococci and high cell counts in smears made from com-

posite herd samples indicate infection of herd members, further examination of such samples seemed important.

All composite control samples revealing long-chained streptococci, or having cell counts of 500,000 or more were retained under refrigeration for the isolation and identification of streptococci. The identification of these streptococci indicated which herds contained infected animals and led to the examination of samples from the individual cows in suspected herds.

The water used for rinsing the Breed pipette between the control samples contained about 50 p.p.m. of chlorine which prevented contamination of one sample by a preceding one.

In most of the tests reported in this paper the samples containing streptococci or many cells were incubated from 4 to 8 hours at 37° C., before streaking on blood agar plates. It was found that many of the plates were so overgrown with gram-negative bacilli that isolation of streptococcus colonies was difficult. All composite producer samples were thereafter inoculated into 10 cc. of fresh sterile 1 per cent sodium carbonate solution, using 2 cc. of the milk sample instead of 1 cc., as suggested by Groesbeck (7) and incubated over-night at 37° C. The samples from individual cows, aseptically drawn, were incubated over-night at 37° C., in their original containers. Blood agar plates were streaked from these incubated samples and incubated at 37° C., for 24 hours. Stained microscopic preparations were made also from the incubated samples. These were examined in order to determine whether an increase in the number of streptococci occurred in the sample upon incubation, and to compare the morphology and colonial appearance of unknown and known strains. Typical streptococcus colonies producing any degree of hemolysis on the streaked blood agar plates were transferred to litmus milk and incubated at 37° C., over-night. Sometimes as many as four colonies were transferred to separate tubes of litmus milk from a single blood agar plate. Microscopic examination of stained smears from these litmus milk cultures was made to determine whether they were pure cultures of streptococci. Transfers were made from the pure cultures in litmus milk to sodium hippurate and esculin broths and incubated at 37° C., for 72 hours. Sodium hippurate and esculin broths of several different compositions were tried before uniform results were obtained as follows:

.1% of esculin in Douglas broth (8)[2]

1% of sodium hippurate in Douglas broth[2]

The original formula and method of Ayers and Rupp (9) was not productive of good growth with all strains of streptococci. Approximately 4 cc. of each medium was tubed for use. To the culture in sodium hippurate was added 1 cc. of a 2 per cent ferric chloride solution in 2 per cent HCl. A positive reaction, the splitting of sodium hippurate, was indicated by a warm-brown

[2] Good growth was obtained also with beef infusion broth.

precipitate. An uninoculated control tube and one inoculated with a known "hippurate-positive" culture accompanied each day's work on unknown samples. About 0.2 cc. of a 1 per cent aqueous solution of ferric citrate was added to the culture in esculin broth. The splitting of esculin, a positive reaction, was indicated by a blackening of the culture upon addition of the reagent. The original fluorescence of the esculin medium was not destroyed by the growth of *Streptococcus agalactiae*. Media containing trehalose and sorbitol were employed in the differentiation of human and animal strains of beta-hemolytic, low-acid producing, hippurate-negative strains of strep-tococci. Transfers were made to both trehalose and sorbitol media from the litmus milk that gave a slight acid reaction. The production of acid in the trehalose or sorbitol media indicated a positive reaction. The base for this media was made by adding to Douglis broth[3] 10 per cent beef serum and 1 per cent Andrade's indicator. To the base was added 0.5 per cent of trehalose or sorbitol, as desired. These media were tubed in 2 cc. quantities.

In order to determine whether or not routine control samples were to be retained for isolation and identification of the streptococci, it was not neces-sary in all cases to find long-chained streptococci in the original smear. Many of the samples from which *Streptococcus agalactiae* were isolated revealed only short chains in the unincubated direct smears. We have found that the size of the individual cells and their arrangement in the chain are of more importance than the length of the chain. Smears for microscopic examina-tion made from litmus milk with the typical curdled reaction of *Strepto-coccus agalactiae* usually contained broken chains of two, three or four units in length. For this reason, smears from litmus milk were made as soon as growth was evident. Re-inoculations from the curdled litmus milk into broth has produced chains of fifteen or more units in length. The charac-teristics of the streptococci most often found in milk are given in Table 1. The most characteristic reaction occurs in litmus milk in which over 95 per cent of the strains produce the (ACR) reaction in from 15 to 48 hrs. of incubation. A few of the strains of *Streptococcus agalactiae* produce acid in litmus milk without curdling it. These variant strains of *Streptococcus agalactiae* differ from *Streptococcus agalactiae* in that they ferment sorbitol and do not curdle litmus milk. The large number of saprophytic strains of streptococci encountered in the routine examination of producer samples also give a very characteristic reaction in litmus milk. The reduction of the color of the dye almost to the surface of the media before curdling, results in a white curdled milk with a narrow red band at the top. Sapro-phytic strains usually produced much shorter chains than those of *Strepto-coccus agalactiae;* the units were larger and were not so closely arranged in the chains, many of them having a "diplo" arrangement.

An acid litmus milk reaction without curdling is produced by the actively

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[3] Good growth was obtained also with beef infusion broth.

TABLE 1
Cultural characteristics of streptococci found in milk

ORGANISM	STREAKED BLOOD AGAR PLATE	LITMUS MILK	SODIUM HIP-PURATE	ESCULIN	TRE-HALOSE	SORBITOL
Streptococcus agalactiae .	alpha alpha prime gamma	ACR	+	−		−
Variant of *Strepto-coccus agalactiae*	alpha	A no C	+	−		+
Streptococcus uberis	alpha	A no C	+	+		⊥
Streptococcus lactis	gamma	ARC	−	+		
Streptococcus fecalis .	gamma	ARC	−	+		
Streptococcus viridans	alpha	A no C	−	±		
Streptococcus hemolyticus (human origin)·	beta	Slight A no C	−	−	+	−
Streptococcus hemolyticus (animal origin)	beta	A 'no C	−	−	−	+

ACR = Acid, slight reduction of color from bottom after curdling.
ARC = Acid, reduction of color nearly to top before curdling.
A no C = Acid, no curd.

hemolytic (beta) colonies and by the green producing (alpha) colonies. This "Acid-no-Curd" reaction is typical of the important group of streptococci which include the human pathogens. The alpha strains produce enough acid from lactose to impart a distinct red color to litmus milk in 24 hrs., while the beta strains rarely make a noticeable change in the color of the litmus milk before two or three days of incubation. All true *Streptococcus agalactiae* strains are negative in sorbitol, while some few variant strains are positive. These sorbitol reactions should not be confused with the sorbitol and trehalose tests of Edwards (10) for the differentiation of human and animal strains of actively beta hemolytic, hippurate-negative streptococci, in which the human (beta) strains ferment trehalose but not sorbitol and the animal strains ferment sorbitol but not trehalose. The splitting of the glucoside, esculin, is characteristic of the saprophytic and fecal strains of streptococci. However, some human strains of *Streptococcus viridans* attack this carbohydrate but they can be separated by their reaction in litmus milk ("Acid-no-Curd").

TABLE 2

Classification of the 441 strains of Streptococci found in the 630 routine control samples in which long chain streptococci or cell counts over 500,000 per cc. were observed

	Streptococcus agalactiae	Variant of Streptococcus agalactiae	Streptococcus uberis	Streptococcus lactis Streptococcus fecalis	Streptococcus viridans (human)	Streptococcus hemolyticus (human)	Streptococcus hemolyticus (animal)
Number	228	12	25	157	18	1.0	0
Per cent	52	3	6	34	5	0.2	0

Table 2 shows the number of each of the seven types of streptococci isolated in this study of 630 samples selected from approximately 6000 routine producer control samples. From the 630 samples, 441 strains of streptococci were isolated, 228 (52%) were *Streptococcus agalactiae*, 12 (3%) a variant of *Streptococcus agalactiae*, 25 (6%) *Streptococcus uberis*, 157 (34%) *Streptococcus lactis*, 18 (5%) *Streptococcus viridans* (human) and one strain of *Streptococcus hemolyticus* of human origin.

All but one of the 228 strains of *Streptococcus agalactiae* produced the (ACR) litmus milk reactions. This one strain differed from *Streptococcus agalactiae* in that it did not curdle litmus milk but was unlike the variant strains since sorbitol was not fermented.

One hundred and forty of the strains of *Streptococcus agalactiae* were obtained from samples giving high cell counts (over 500,000 per cc.) and showing streptococci in the direct microscopic smear of the unincubated samples; 60 were from samples showing streptococci and low cell counts (under 500,000 per cc.) and 28 were from samples with high cell counts only. Besides the 28 strains of *Streptococcus agalactiae* isolated from the high cell count samples, 5 samples yielded strains of *Streptococcus lactis*, 4, strains of *Streptococcus uberis* and 2, strains of *Streptococcus viridans* (human).

Although approximately 50 per cent of the *Streptococcus agalactiae* were from samples in which long chained streptococci predominated in both the unincubated and incubated microscopic smears, the finding of long chained streptococci was not always indicative of *Streptococcus agalactiae* as 35 per cent of the *Streptococcus lactis* and *Streptococcus fecalis* strains produced long chains in the microscopic milk smears. Over 40 per cent of the *Streptococcus agalactiae* were from samples containing short chains. These strains grew in short chains in pure culture. The morphology of the strains of streptococci from milk was not characteristic. This was evident when notice was taken of the changes produced in some stock cultures grown on

different types of media and incubated and stored at different temperatures. *Streptococcus agalactiae* were isolated from 28 samples in which no streptococci were found in the unincubated microscopic smear. Colonial appearance, exclusive of hemolysis, contributes little to the identity of milk streptococci. Likewise the type of hemolysis on streaked blood agar plates after 24 hrs. of incubation was no indication of the identity of different strains of *Streptococcus agalactiae* since—83 strains of the *Streptococcus agalactiae* were from alpha colonies.

96 strains of the *Streptococcus agalactiae* were from alpha prime colonies.

49 strains of the *Streptococcus agalactiae* were from non-hemolytic (gamma) colonies.

Our work did not agree with that of Frost (11) in that no actively hemolytic (beta) mastitis strains were found in this study. This may be due to differences in the technic of making the blood agar cultures.

The laboratory detection of mastitis infection which for the most part was not recognized by physical inspection of animals and the "Brom Thymol Blue Tests" indicates the value of the routine laboratory procedure. Tests on samples from individual cows were made when a composite test indicated infection in the herd, or when infection was suspected by the producer or inspector. Elimination of the infected animals or at least their segregation at the end of the milking line was recommended. In most herds by complying with these recommendations there was a noticeable decrease in the number of streptococci and cell count of the herd milk and apparently less spread of infection in the herd.

In this study we found 42 badly infected herds. So far, individual cow samples have been examined from eleven of these herds and 48 animals have been removed from the milking lines. In 2 of these herds where the animals were not removed, the disease spread throughout the entire herd within a year's time. After identification of *Streptococcus agalactiae* from the composite milk of one herd, individual cow samples were examined from the 22 animals in the herd. Eight were found which were shedding *Streptococcus agalactiae* but showed no physical symptoms of the disease. The animals were not removed from the herd and after approximately a year the producer was not permitted to ship milk for fluid consumption because of consistently high counts. In a second herd from which it was recommended that 6 animals be removed, failure to remove these animals resulted in the loss of the entire herd in less than a year's time.

During the summer months many producers were degraded because of high bacterial counts. In many of the smears prepared from these samples, streptococci were observed and isolated. Examination of samples from individual cows revealed the offending animals which were removed from the milking line with a subsequent regrading of the producers.

A producer of grade "A" raw milk was degraded because of high bacterial counts. Inspection of equipment and animals and supervision of his methods of production caused no lowering of the counts. Samples from individual cows were examined. Seven of the 25 cows were found shedding streptococci in numbers sufficient to cause the composite milk to be degraded. The removal of these animals from the milking line likewise caused a subsequent regrading of the producer.

CONCLUSIONS

A series of cultural tests has been used routinely in a public health laboratory by which the identity of streptococci occurring in raw composite control milk samples has been determined.

These tests consist of a preliminary incubation of the sample and subsequent streaking on blood agar, from which the hemolytic streptococcus colonies are transferred to litmus milk. Plantings are made from the pure cultures, having characteristic reactions in litmus milk, to sodium hippurate and esculin broths. The beta hemolytic strains are tested for their ability to utilize trehalose and sorbitol.

When used routinely, with control samples, these tests supply a rapid method of locating herds containing animals with mastitis infections.

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A COMPARISON OF STANDARD PLATE COUNTS AND METHYLENE BLUE REDUCTION TESTS MADE ON RAW MILK WITH SPECIAL REFERENCE TO GEOMETRIC MEANS[1]

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It has been demonstrated (1) that the logarithmic or geometric mean is fairer and truer than the arithmetic mean in averaging plate counts made on milk samples. The geometric mean gives proper credit to the fact that bacteria multiply in a geometric progression. Also, the occasional extremely high or low count is more fairly handled when the geometric mean is obtained.

In an effort to determine the geometric mean of plate counts for each of the four methylene blue reduction test classes of milk, data were collected on approximately 1100 samples of raw milk. The number of samples of class four milk was not very large, consequently the data concerning this milk are to be considered as a progress report. The numbers of samples of the first three classes were sufficient to make the results significant.

Samples of raw milk were collected at the weigh vats of several dairies which were being supplied by approximately one thousand farms. Standard plate counts (2) were determined and at the same time the samples were classified according to the methylene blue reduction test (2). The results, after the counts were grouped in a geometric progression fashion since bacteria reproduce in this manner, are given in Table 1. The range of counts was wide for each class, which resulted in considerable overlapping of the range of counts of one class by that of another.

The class two range starts with a count which was one of the most common among the class one milks. Likewise the class three range starts with a count which was one of the most common among the class two milks. The geometric mean of the standard plate counts for class one was found to be 11,500, which on a frequency basis would be included among those counts most frequently encountered for class one milks. The same is true for the geometric mean of class two, 153,900. The geometric mean of classes three and four were 905,200 and 2,796,400 respectively.

The results in Table 1 were obtained from logarithms of the original counts of samples in the four classes. Practically two-thirds of the counts in each class were within one standard deviation of the mean of the loga-

TABLE 1

Frequencies of plate counts and reduction tests made on raw milk

STANDARD PLATE COUNTS (GROUPS)	METHYLENE BLUE REDUCTION TEST (CLASSES)			
	1 No. of samples	2 No. of samples	3 No. of samples	4 No. of samples
500– 1,000	5			
1,001– 2,000	28			
2,001– 4,000	71			
4,001– 8,000	116	2		
8,001– 16,000	117	14		
16,001– 32,000	61	33		
32,001– 64,000	50	59		
64,001– 128,000	34	84	5	
128,001– 256,000	10	86	15	
256,001– 512,000	8	51	19	1
512,001– 1,024,000		36	32	8
1,024,001– 2,048,000		22	38	7
2,048,001– 4,096,000		10	15	7
4,096,001– 8,192,000		4	9	13
8,192,001–16,384,000				4
Totals	500	401	133	40
Range	1M–500M	5M–6$\overline{\text{M}}$	80M–8$\overline{\text{M}}$	400M–15$\overline{\text{M}}$
* Geometric mean	11,500	153,900	905,200	2,796,400
Mean of logarithms	4.05996	5.18713	5.95674	6.44676
Standard deviation of mean of log.	.02371	.02932	.03910	.06500
** Per cent of counts within 1S.D. of mean	66.2	67.8	67.7	63
** Per cent of counts within 3S.D. of mean	99.7	100	100	100

* This was obtained from the logarithms of the original counts.
** For a normal frequency curve approximately 68 per cent of the sample will be within ± one standard deviation of the mean and approximately 99 per cent within three ± standard deviations.

rithms; more than 99 per cent of the counts in each class were within three standard deviations of the mean of the logarithms, hence no count was discarded.

In a statistical analysis of this type there is always the possibility that the separation between groups or in this case between geometric means may not be significant, which would indicate the possibility of improperly classifying some samples. In order to ascertain the significance of these geometric means found for the different classes of milk, a test for significance (t) was applied.

The means of the logarithms of the counts of bacteria and the standard deviations of these means were obtained for each class. The respective means and their standard deviations for two successive classes were substituted in the following formula to test the significance of the difference of the geometric means. The formula for (t) is

$$t = \frac{\text{Mean log } x_2 - \text{Mean log } x_1}{(\sigma_{\text{mean of log } x_2})^2 + (\sigma_{\text{mean of log } x_1})^2}$$

where x_2 represents the counts of bacteria from one class and x_1 represents the counts from another class, and $\sigma_{\text{mean of log}}$ the respective standard deviation.

If any two geometric means are significantly different, the value of (t) will be in excess of 2.5 (3). The values of (t) for milk classes I and II, II and III, and III and IV were found to be respectively 29.9, 15.7 and 12 2, which means that the geometric means as found are significantly different. These (t) values clearly indicate that the four class geometric means did not come from the same parent population by random sampling and that this test (methylene blue test) will designate the different classes of milk

SUMMARY

1. The analysis of data of standard plate counts and methylene blue reduction tests of approximately 1100 samples of raw milk is given.

2. The range and frequencies of counts are given for each class as well as the geometric mean and standard deviation.

3. Practically two-thirds of the counts in each class, as determined by the reduction test, were within one standard deviation of the mean of the logarithms and more than 99 per cent of the counts in each class were within three standard deviations of the mean of the logarithms.

4. The geometric means found for the four different classes of milk were found to be significantly different when a test for significance was applied.

5. No attempt has been made in this paper to fix the limits (counts) of the four different classes   This paper shows that the geometric means of the methylene blue classes are significantly different.   By examining the standard deviations of the means of the logarithms in Table 1 it is seen that the distributions of the geometric means do not overlap.

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A STUDY OF OILING OFF OF CREAM IN COFFEE*

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The fat emulsion in cream is frequently destabilized to the extent that some of the fat will rise to the surface when the cream is used in coffee. This fat which separates appears on the surface of the coffee in the form of glistening oil droplets or globules which are easily discernible to the coffee drinker. This phenomenon, when it occurs in coffee, is usually referred to by the dairyman as "oiling off."

The oiling off of cream in coffee is objectionable to some consumers of coffee. Buyers for restaurants and hotels frequently place considerable stress on this point when judging coffee cream. They prefer a cream in which the fat emulsion is stable, not only because oiling off is considered objectionable but also because cream with finely dispersed fat phase has a greater effect on the color of the coffee and cream mixture. From these remarks it is obvious that the extent of the oiling off of cream in coffee is of economic importance to the dairyman.

The authors are aware of no references in the literature to the factors causing the oily separation from cream in coffee. However, several studies have appeared which dealt with the changes in the fat emulsion which cause such defects as the cream "plug" in bottled milk or cream, serum separation in bottled cream, and the oily layer on frozen cream when melted. Since the need for research regarding the specific defect of oiling off of cream in coffee was evident, this investigation was carried out.

EXPERIMENTAL METHODS

The facilities of the New England Dairies, Inc., offered an excellent means for the study of this problem. In the several country receiving stations of this corporation various methods of processing cream and a number of types of pasteurizing vats, cream pumps, coolers, etc., were available for investigation. The cream processed in the various country plants could be followed easily as it was shipped to city bottling plants and prepared for delivery.

The need for a suitable test for oiling off was apparent at the beginning of the study. The authors were aware of the hot water and coffee tests applied to cream in the laboratories of several dairy companies. In these

tests a definite amount of cream is added to 100 cc. of hot water or hot coffee, then the surface of the liquid is examined under the light from a shaded electric light. The globules of oil which separate from the cream will glisten under the light. Using a numerical standard for grading, a badly oiled cream is usually called 4, a desirable cream 0. Such a test though helpful, is subject to the human error of judgment and is not sufficiently accurate to measure small but significant differences.

An attempt was made to develop a microscopic method for measuring the stability of the fat emulsion in cream. However, no definite relationship could be found between the microscopic appearance of the fat globules and their arrangement in diluted cream and the factor of oiling off in coffee.

The test which was developed for use in this investigation has been named the M.S.C. test for oiling off because it was worked out at the Massachusetts State College as a part of this investigation. The test is based on the fact that the globules causing the oily layer are much larger than the normal fat globules of cream and will rise to the surface much more rapidly than the rest of the fat phase. This fat can be centrifuged from a cream-hot water mixture in a regular Babcock skim milk test bottle and can then be measured in the graduated portion of the bottle. The following procedure for the test was adopted after considerable experimentation:

1. One cc. of cream is pipetted into a skim milk test bottle. The skim milk test bottle used should be of the type with the stem extending down into the bottle proper to within one-half inch of the bottom. The stem should have no side hole near the base of the neck as in some styles. The cream sample must be thoroughly mixed and the one cc. taken out immediately so that the oil will not have time to rise to the top of the sample.

2. Wash down the cream in the stem with water at 200° F. and mix by rotating when the water is one-half inch deep in the base of the test bottle, then fill to the shoulder of the bottle which is about one-half inch from the base of the neck.

3. Centrifuge in a heated Babcock machine for positively no longer than ten seconds after the machine has reached speed. If the sample is whirled longer than ten seconds a plug will form which is hard to put back into suspension and the particles will clog the neck.

4. Remove the bottle from the centrifuge and tap the side of the bottle to break the very thin film which has formed. Do not agitate.

5. Now add water again at 200° F. and bring the column well up into the neck.

6. Centrifuge for five minutes.

7. Read the oil layer as soon as removed from the hot centrifuge. Each small division of the graduated scale may be read as 1.

The operator of the M.S.C. test should follow the directions closely. Some difficulty was experienced at first with the test in securing duplicate

results. However, after sufficient experience it became evident that strict adherence to the routine of the test as well as thorough mixing of the cream and quick pipetting of the sample are all very essential if accurate readings are to result.

No attempt has been made to convert the readings to a quantitative expression of the amount of oil separating from the cream. For that reason it is suggested that the readings be given in whole numbers, with the smallest division on the neck of the bottle as 1.

Obviously, the fat which is separated in the test should not be read quantitatively since the one cc. of cream used in the determination is not weighed and the creams being tested vary in fat content. Measuring the cream is more satisfactory than weighing because (1) the slight variations in weight from sample to sample produce no noticeable variations in the results and (2) speed in taking the sample is essential. The sample being tested should be stirred thoroughly and 1 cc. pipetted from it promptly. Our experience indicates that the separated oil droplets will tend to rise rapidly towards the surface of the cream sample.

This test is now being used satisfactorily in commercial laboratories in Boston. Creams which produce readings of 1 division or less do not show an oily separation when used in coffee; creams with a reading of two divisions are usually considered acceptable while those with a reading of three or more oil off in coffee to a noticeable degree and are considered unsatisfactory by many cream buyers.

EXPERIMENTAL RESULTS

The results given in Tables 1 to 5 show the effect of a number of processes and types of equipment on the stability of the fat emulsion in cream.

In Table 1 the effects of several receiving plant processes are given. When approximately 40 per cent of the milk received was partially frozen, the test on the resultant cream was 3 and, as stated previously such cream is unsatisfactory for use in coffee. Part 2 of Table 1 shows that the test of the milk being separated, so long as the milk is normal in other respects, has a normal reading of 1 or less. However, the separation temperature is important (Table 1, Part 3). As the separating temperature is increased, the tendency to oil off increases. Temperatures of 85° F. and 90° F. gave normal results; a definite increase appeared at 120° F.; and 140° F. (with mechanical agitation in the preheater) damaged the emulsion to the extent that the cream tested 3, hence would oil off noticeably in coffee.

The fat content of the separated cream evidently does not influence the stability of the fat emulsion unless the cream contains 50 per cent butter fat or more (Table 1, Part 4). The results show that an increase in the reading for oiling off was evident with 50 per cent cream, but not for cream of lower fat content.

TABLE 1

The effect of some properties of milk and certain receiving plant processes on the oiling off factor in the resultant cream

FACTOR OBSERVED	TREATMENT OF MILK OR CREAM	AMOUNT OF OILING OFF (M.S.C. TEST READING)	
1. Effect of freezing milk	40% of milks partly frozen when received		
A. Normal milk		.5 divisions	
B. Partially frozen milk		3.0 "	
2. Test of milk separated	Separated at 90° F., cooled, cream raw		
A. 4.7% milk		.5 divisions	
B. 4.0% "		.5 "	
3. Separating Temperatures			
A. 85° F.	Internal tubular preheater used	.5 divisions	
B. 90° F.	" " "	.5 "	
C. 120° F.	" " "	1.0 "	
D. 140° F.	Barrel heater, with paddle agitator used	3.0 "	
4. Test of separated cream	Cream separated at 90° F., not pasteurized		
A. 30% cream		.5 divisions	
B. 40% "		.5 "	
C. 45% "		.5 "	
D. 50% "		1.0 "	
		Reading Before Stand.	After Stand.
5. Temperature of cream when standardized	Creams standardized to 40% fat		
A. 90° F.		.5	.5
B. 120° F.		1.0	1.0
C. 135° F.		1.0	1.0
D. 145° F.		1.0	1.0
6. Standardization Product	The tests were run on the cream before and after standardization at 120° F.		
A. 4.0% milk		1.0	1.0
B. Skimmed milk		1.0	1.0

TABLE 2

Effect of handling the cream in the pasteurization vat on the oiling off factor of the cream

FACTOR OBSERVED AND TREATMENT OF CREAM	AMOUNT OF OILING OFF IN CREAM (M.S.C. TEST READING)	
	RAW CREAM	BEFORE 30′ HOLDING PERIOD
1. Treatment of cream in vat		
A. Held at 90° F. until vat is full before heating is begun	.5 division	1.0 divisions
B. Heating of cream done while vat fills	.5 ″	1.0 ″
2. Prolonged holding of cream prior to the pasteurization process	*Before holding*	*After holding*
A. Cream cooled to 50° F., held 3 hrs. without agitation	.5 ″	1.0 divisions
B. Cream held at 90° F. for 3 hrs. without agitation	.5 ″	1.0 ″
C. Cream held at 135° F. for 3 hrs. without agitation	.5 ″	3.0 ″
D. Cream held at 135° F. for 4 hrs. with agitation	.5	4.0 ″
3. Time cream is held at the pasteurization temperature	*Before holding*	*After 30′ holding*
A. Cream held at 145° F. for 30 min.	1.0 division	1.0 divisions
B. ″ ″ ″ ″ 40 ″	1.0 ″	2.0 ″
C. ″ ″ ″ ″ 50 ″	1.0 ″	2.0 ″
D. ″ ″ ″ ″ 70 ″	1.0 ″	3.0 ″

4. Amount of cream in vat	Raw cream	Before holding	After 30′ holding	After cooling
A. Spray vat, 800 qt. capacity, filled with cream	.5	1.0	1.0	1.0
B. Spray vat, 800 qt. capacity, one-fourth full	.5	2.0	4.0	4.0

In the receiving stations where these observations were made, the separators are adjusted to separate cream testing a little higher than 40 per cent butter fat. The cream is then standardized to a fat content of 40 per cent prior to pasteurization. The results in Part 5 of Table 1 show that the cream can be standardized at any temperature up to the pasteurization temperature without any marked tendency towards oiling off, although slightly better results were secured when standardization was done while the cream was below 120° F.

Either skimmed milk or whole milk may be used for standardization. It is evident from Part 6 of Table 1 that neither of these products increases the tendency to oil off when used to reduce the fat content of high testing cream.

Various factors involved in the pasteurization of cream, which might affect the stability of the fat emulsion, are summarized in Tables 2 and 3.

In some receiving stations cream is gradually heated to the pasteurization temperature while the vat fills with cream. In other instances the cream is not heated until the vat is filled. In either case the cream is not agitated while the vat fills. Part 1 of Table 2 shows that the two methods have the same effect on the tendency to oil off. An increase in the reading to a value of 1 must be considered as a normal increase which cannot be avoided. Raw cream showing little or no oil separation will have a reading of 1 when brought to the pasteurization temperature.

From Part 2 of Table 2 it is evident that freshly separated cream can be held without agitation for at least 3 hours, either at 50° F. or 90° F. without decreasing the stability of the fat emulsion. However, it is very evident that the cream should not be held at 135° F. for any length of time for with this treatment a test for oiling off gave readings of 3 and 4 points. The holding temperature of cream before pasteurization is of significance because in some receiving stations considerable time elapses before the vat is filled with cream and pasteurization is begun. In some plants the cream is cooled to 50° F., and in others it is held at the separation temperature of 90° F. Either practice is satisfactory. But in plants where the cream is held a few degrees below the pasteurization temperature for some time the stability of the fat emulsion is evidently damaged.

The length of the holding period in pasteurization is also of significance (Table 2, Part 3). As is evident from these data, no increase in oiling off occurs during the 30 minute holding period at 145° F. but an increase of only 10 minutes in the holding period increased the reading 1 point, a significant amount. When the holding period was increased to 70 minutes, the cream oiled off considerably in coffee, as the reading of 3 indicates.

The fullness of the vat is also of importance. When a "spray vat" was filled with cream the pasteurization process did not injure the fat emulsion. However, when the same vat was less than half full of cream, the pasteuriza-

TABLE 3

Effect of type of vat, temperature of heating medium, type of agitation and method of pumping cream to cooler on the oiling off factor in cream

FACTOR OBSERVED AND TREATMENT OF CREAM			AMOU'NT OF OILING OFF (M.S.C. TEST READING)			
Type of vat	Temp. heating medium	Type of agitation	Raw cream	Before holding	After holding	After cooling
1. Type of vat						
A. Stainless steel spray	150° F.	Slow speed paddle	.5	1.0		
B. Stainless steel spray	190	Slow speed paddle	.5	3.0		
C. Glass lined steel	160	Slow propellor	.5	1.0		
D. Glass lined steel	212	Fast propellor	.5	4.0		
E. Coil vat	160	Slow speed coil	.5	3.0		
F. Coil vat	210	Slow speed coil	.5	3.0		
2. Agitation during holding period of 30 min. Cream at 145° F.						
A. Stainless steel spray vat, slow paddle agitation			.5	1.0	1.0	
" " " no agitation			.3	1.0	1.0	
B. Glass lined vat with slow propellor agitation			.5	1.0	1.0	
" " " " no			.5	1.0	1.0	
" " " " fast			.5	3.0	5.0	
3. Temperature of pasteurization.						
A. Cream pasteurized at 143° F. in stainless steel vat, no agitation during holding period.			.5	1.0	1.0	
B. Same as A, except at 150° F. pasteurization temperature.			.5	2.0	2.0	
C. Same as A, except at 160° F. pasteurization temperature.			.5	2.0	2.0	
4. Pumping cream from pasteurizer to surface cooler by						
A. Proper size centrifugal pump.					2.0	2.0
B. Oversize centrifugal pump.					3.0	4.0
C. Steam piston pump.					1.0	1.0
D. Steam piston pump.					3.0	2.0

tion process caused the test to increase to 4 points and the cream oiled badly in coffee.

The data given in Table 3 indicate that the type of vat, temperature of heating medium, and type of agitation all affect the stability of the fat emulsion in cream. Stainless steel spray vats with slow-speed paddles and glass-lined steel vats with slow-speed propellor agitators proved satisfactory when used with a heating medium of 160° F. However, coil vats increased the reading to 3, regardless of the temperature of the heating medium. Hence it is evident that this type of vat should not be used for pasteurizing cream if oiling off of the cream in coffee is to be prevented.

Good results were secured in spray vats and glass-lined steel vats, with slow agitation and a heating medium of 160° F. However, if the heating medium was increased to 190° F., or the speed of the agitator increased, then the cream was made less stable against oily separation in coffee (Table 3, Part 1).

Part 2 of Table 3 shows that holding cream during pasteurization in spray or glass-lined steel vats, either with slow-speed agitation or with no agitation at all produces identical results. Therefore agitation of the cream during the holding period can be practiced, if desired, with the knowledge that no harm to the fat emulsion is being done. However, the tendency to oil off was noticeably increased when the propellor agitator in the glass-lined steel vat was shifted to high speed, both during the heating period as well as during the holding period.

Part 3 of Table 3 shows that heating the cream to a pasteurization temperature of 150° and 160° F. causes an increase in the test for oiling off to a reading of 2. The figures show that there is no increase in free oil during the holding period but rather the increase occurs during the heating process. The longer heating period, with necessarily a longer period of agitation, undoubtedly causes this increase.

The type of pump used to transfer cream from the pasteurizing vat to the cooler was also studied (Part 4 of Table 3). The data show that no increase in the oiling off test reading occurred when a proper size centrifugal pump was used but when an oversize pump was used evidently more agitation occurred, which caused the reading to increase. The steam piston pump also proved satisfactory. In fact the results indicate that with cream which already has a high reading, the piston pump tends to re-emulsify the separated oil. This is evidently the case for in test D of Part 4, Table 3, the test for oiling off was actually lowered a point while the cream passed through a steam-driven piston pump.

Examination of Table 4 reveals that no increase in the tendency to oil off occurs during cooling of cream if agitation within the temperature range of 40° to 100° F. is prevented. Complete cooling of cream over a surface cooler or cabinet cooler caused no increase in the test; this is also true with

partial cooling (to 120° F.) in spray vats and stainless steel vats, with slow agitation, then followed by the use of a surface cooler. However, when cream was cooled to 50° F. in a spray vat the test for oiling off showed a 2 point increase. Complete cooling in a coil vat also caused a marked increase in the free oil content of the cream.

From Part 2 of Table 4 it is evident that the stability of the fat emulsion is not affected by cooling cream over the surface cooler to 40° rather than 50° F. However, when some cream froze to the lower coil of the surface cooler the results show a considerable increase in free oil. The authors have found this to be a common cause of oiling off of cream in coffee.

The aging of cream for 24 or 48 hours after pasteurization had no effect on the stability of the fat emulsion (Part 3, Table 4).

TABLE 4

Effect of methods of cooling cream, aging, and shipment on the oiling off factor in the cream

TREATMENT OF CREAM	EXTENT OF OILING OFF (M.S.C TEST READING)	
	After holding	After cooling
1. Method of cooling cream.		
A. Large surface cooler.	1.0	1.0
B. Cabinet cooler.	1.0	1.0
C. Partial cooling in spray vat then pumping over surface cooler.	1.0	1.0
D. Complete cooling in spray vat.	4.0	6.0
E. Partial cooling in glass lined vat with fast propellor agitator.	3.0	3.0
F. Partial cooling in glass lined vat with slow propellor agitator.	1.0	1.0
G. Complete cooling in coil vat.	5.0	7.0
2. Temperature to which cream is cooled.		
A. Drawn from surface cooler at 40° F.	1.0	1.0
B. Drawn from surface cooler at 50° F.	1.0	1.0
C. Some freezing on brine section of surface cooler.	3.0	6.0
		After aging
3. Aging cream at 38° F.		
A. No hours.		1.0
B. 24 "		1.0
C. 48 "		1.0
	Before shipment	After shipment
4. Transportation of cream at 40° F.		
A. Full can of cream shipped by train.	1.0	1.0
B. Full can of cream shipped by truck.	1.0	1.0
C. Half-full can of cream shipped by train.	1.0	2.0
D. Half-full can of cream shipped by truck.	1.0	4.0

Transportation of cream at approximately 40° F., either by train or truck, did not decrease the stability of the fat emulsion of the cream providing the cans were filled. However, in partially filled cans enough agitation occurred to increase the test reading for oiling off by one point when the cream was shipped by rail and by 3 points when transported by truck (Part 4, Table 4). The handling distance in each instance was about 140 miles.

Some milk distributors purchase sweet cream for bottling and standardize it merely by mixing it with cold pasteurized milk. When cream with a stable fat emulsion is treated in this way, no damage is done and the resultant standardized creams do not oil off (Part 1, Table 5). However, when cream testing 40 per cent butter fat, which oiled off badly, was reduced by this method to 30 and 20 per cent fat the lower testing creams also oiled off to the same extent as the original cream.

Cream which has been destabilized by any of the previously discussed factors can be made entirely satisfactory by homogenization (Part 2, Table 5). The data show that cream with a reading of 4, when tested for the degree of oiling off, was made entirely stable by a homogenization pressure of 500 pounds per square inch. A pressure of 300 pounds is practically as efficient. Some of the unstable cream was also passed through a colloid mill at a pressure of 150 pounds per square inch and through a "hand emulsor" made for home use. Both of these machines partially re-emulsified the free oil but were less satisfactory than the homogenizer.

Data have been omitted for the sake of brevity concerning several points which were studied. Varying the mineral content of cream by the addition of sodium citrate or lime water produced no perceptible effect on the oiling off factor in cream. This also proved true when gelatin was added to cream and when the acidity of the cream varied within the limits encountered in commercial practice.

The method used in making coffee seems to have no effect on the stability of the fat in the cream added to the coffee. Whether coffee was poured into the cup before the cream or *vice versa* had no effect on the appearance of oil on the surface of the coffee. A few different brands of coffee were used but none seemed to increase the oily layer appearing on the cream and coffee mixture.

Cream which was allowed to stand at room temperature for several hours lost its stability and oiled off in coffee. However, cream which was kept in a refrigerator except at meal time did not deteriorate appreciably after three days in respect to oiling off when used in coffee.

SUMMARY AND CONCLUSIONS

1. A suitable test for measuring the extent to which cream will oil off in coffee has been developed and is presented as a part of this paper. Creams

TABLE 5

The effect of standardization and homogenization on the oiling off factor in cream

TREATMENT OF CREAM	AMOUNT OF OILING OFF (M S.C. TEST READING)
Standardization of cream	
A. Pasteurized 40% cream	1.0
A₁ Same as A but reduced to 30% cream, using whole milk	1.0
A₂ Same as A but reduced to 20% cream, using whole milk	1.0
B. Pasteurized 40% cream	3.0
B₁ Same as B but reduced to 30% cream, using whole milk	3.0
B₂ Same as B but reduced to 20% cream, using whole milk	3.0
Re-emulsification of fat in cream which oils off	
A. Control—cream pasteurized and cooled	4.0
B. Same cream as the control, except homogenized at 500 lbs. pressure	0
C. " " " " " " " 1000 " "	0
D. " " " " " " " 1500 " "	0
E. " " " " " milled in colloid mill at 150 lbs. pressure	.5
F. Same cream as the control, except passed through "hand emulsor"	2.0

yielding a reading of 3 or above with this test will show a noticeable oily separation when used in coffee.

2. A number of factors have been studied which affect the stability of the fat emulsion in cream and have a bearing on the problem of oiling off of cream in coffee. The more important factors are summarized as follows:

a. When milk which has been partially frozen is separated, the resultant cream will produce an oily separation in coffee.

b. As separating temperatures are increased above 90° F. the fat emulsion in the cream becomes progressively less stable when the cream is used in coffee. Mechanical agitation of the milk during preheating prior to separation proved undesirable. Separating milk into cream of more than 45 per cent fat also caused a decrease in the stability of the fat emulsion.

c. The temperature of cream when standardized in fat content by the addition of whole or skimmed milk has no effect on the fat emulsion.

d. If vats are filled rapidly with cream and heated slowly to 145° F. a minimal increase in the tendency to oil off results. When vats fill slowly equally desirable results are secured if the cream is held below 90° F. and not agitated. Agitation and the heating of cream to a temperature near that of pasteuriaztion are undesirable practices and cause the oily separation.

e. Prolonged holding of cream at the pasteurization temperature increases the amount of destabilized fat in cream. The partial filling of pasteurization vats causes similar undesirable results. Stainless steel or glass-lined steel vats with slow propellor or paddle agitation, and a heating medium of 160° F., produced satisfactory results. However, an increase in the speed of agitation or in the temperature of the heating medium, in these same vats, increased the oiling off tendency. Coil vats, regardless of the temperature of the heating medium destabilized the fat emulsion. Heating cream to pasteurization temperatures higher than 145° F. increased the test for oil separation slightly. Whether cream is agitated slowly or not at all during the holding period apparently made no difference, but rapid agitation caused oiling off.

f. Pumping cream from pasteurizer to cooler by proper size centrifugal pumps had no effect on the fat emulsion, while the use of oversize pumps destabilized the fat to some extent. Steam piston pumps do not affect the fat emulsion adversely; in fact, with cream which oiled off badly, the piston pumps partially re-emulsified the fat which had separated.

g. Cooling cream in the pasteurizing vat was found to be very undesirable regardless of the type of agitation employed. The final temperature to which cream is cooled over a surface cooler does not affect the fat emulsion so long as freezing on the cooler does not occur. Freezing of

cream to the cooler was found to be one of the most serious causes of oiling off of cream in coffee.

h. Aging cream (without agitation) at low temperature caused no change in the stability of the fat emulsion. Shipment at low temperature also had no effect unless the cans were partially filled, thus allowing for agitation which proved harmful.

i. Reducing the fat content of pasteurized cream by the addition of milk or skim milk had no effect on the tendency of the cream to oil off.

j. Cream which had been improperly handled, so that droplets of oil would separate from it if used in coffee, was made entirely stable by homogenization of the cream at the pasteurization temperature. A pressure of 500 pounds was used. Attempts to re-emulsify the fat by the use of a colloid mill and manually operated emulsor were partially successful.

k. Storage of cream for three days in a household refrigerator did not increase the tendency to oil off when the cream was used in coffee.

THE COMPOSITION OF LIMONITES EFFECTIVE AND INEFFECTIVE IN CORRECTING "BUSH SICKNESS" IN CATTLE

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Bush sickness of sheep and cattle on certain soil areas in New Zealand resembles "salt sick" (nutritional anemia) on definite areas in Florida, hence there is mutual interest in problems relating to these conditions. It was desired to compare the composition of supplements used to correct these conditions. realizing however that differences in soils over which livestock graze also affect the amounts of mineral elements in the feed supply. An exchange of iron supplements used in the correction and prevention of bush sickness was effected between the New Zealand Department of Agriculture and the Florida Agricultural Experiment Station through the courtesy of Dr. B. C. Aston, Chief Chemist, New Zealand Department of Agriculture. Two samples of native iron-bearing ore, "limonite," tested as correctives for bush sickness, were received. Although these samples of limonite were in many respects the same, one of them from Whangarei (Ruatangata) was effective against the anemia, whereas the other from Puhipuhi was ineffective.

The New Zealand limonite samples were subjected to spectrographic analysis in the Spectrographic Laboratory of the Florida station. The results of these analyses are not "precision" data, but rather are estimates based on ratio quantitative comparisons with standards. There was quite close agreement in the main between the analyses by chemical methods as reported by Grimmett and Shorland (2) and these spectrographic analyses (see Table 1) even though the samples may have originated at different points in these mineral deposits. Additional elements likely to prove beneficial, or have unfavorable effects, were sought in the spectrographic analysis, including bismuth, cadmium, lead, lithium, molybdenum. silver, strontium, thallium, tin, tungsten, yttrium, vanadium and zinc.

Of the elements mentioned, bismuth, cadmium, lead, lithium, silver, thallium, tungsten, yttrium and zinc were not detected in either ore.

The effective and ineffective ores both contained .001 per cent of the elements chromium, molybdenum and vanadium. Both samples were shipped in tin containers, which are suspected of being the source of the

TABLE 1

Comparison of spectrographic and chemical methods of analysis of effective and ineffective limonite ores used in treatment of bush sickness in New Zealand cattle and sheep

	SPECTROGRAPHIC ANALYSES*		CHEMICAL ANALYSES (2)	
	Effective ore	Ineffective ore	Effective ore	Ineffective ore**
	Per cent	*Per cent*	*Per cent*	*Per cent*
Alumina (Al_2O_3)	2.00	2.00	5.24	2.54
Antimony trioxide (Sb_2O_3) ...	not found	.1	not found	.04
Arsenic trioxide (As_2O_3) .	not found	present	trace	.033
Barium oxide (BaO)	.001	.1	not given	.27
Calcium oxide (CaO)	present	present	.58	.65
Chromium sesquioxide (Cr_2O_3) ..	.0015	.0015	not found	not found
Cobaltous oxide (CoO) . . .	.005	not found	trace	trace
Cupric oxide (CuO) . .	.015	.015	.08	not found
Manganese dioxide (MnO_2) .	.80	.80	.79	2.45
Molybdenum trioxide (MoO_3) .	.0015	.0015	. .	
Nickelous oxide (NiO) .	.0005	.0015	.01	trace
Strontium oxide (SrO) . . .	not found	.006	. .	. . .
Stannic oxide (SnO_2) .	.006	.006	.	
Titanium dioxide (TiO_2) .	.15	.30	.31	.40
Vanadium pentoxide (V_2O_5) .	.002	.002	.	
Alkalis (K_2O, Na_2O) . .			trace	.02
Carbon dioxide (CO_2) . .				.49
Ferric oxide (Fe_2O_3) .			62.30	71.25
Phosphorus pentoxide (P_2O_5) .			.82	.40
Silica (SiO_2) .			7.79	6.33
Sulfur (S) .			not found	.16
Magnesia (MgO) . .	.	.	.05	.08
Loss on ignition .	.	..	13.01	12.12
Moisture . .	(..	. .	9.59	3.20

* Determined as elements; calculated to oxide equivalent for comparison.
** Fusion analysis by Mr. Seelye, courtesy of the New Zealand Dominion Analyst.

.005 per cent of tin found in each sample. The ineffective sample contained 100 times as much barium (.1 to .001 per cent Ba), as did the effective sample. Barium may be a factor to consider with regard to the ineffectiveness of the Puhipuhi limonite. The ineffective ore also contained .005 per cent strontium not found in the effective ore. These percentages of the elements as determined spectrographically, have been computed to their oxide equivalents for comparison with the chemical analyses of similar samples of ore from the same deposits, as shown in Table 1.

Approximately equal amounts of copper were found consistently in both samples, even upon 12 replicate determinations. The spectrographic method of analysis does not entail contaminations with reagents, and hence is more reliable than usual chemical estimations when dealing with *small amounts* of copper.

Cobalt was not found in the ineffective limonite by spectrographic examination. Even with 10 to 15 times longer exposure of the photographic plates, no cobalt line was found on the negative. The effective limonite, however, contained .005 per cent of the element. In view of the recent work of Underwood and Filmer (1, 4), and unpublished results by Neal (3) at the Florida station, it appears that cobalt is an essential element in animal nutrition.

Cobalt then appears worthy of further investigation in conjunction with ineffective ores. Its absence may explain the ineffectiveness of the Ruatangata ore, and also that of another ineffective ore (Onekaka) in which Grimmett and Shorland (2) did not find the element.

Beryllium, a metal with potential commercial value, was encountered in the systematic search of the spectrograms of the Puhipuhi limonite. Although only a small percentage was found (.005 per cent Gl), its presence may indicate the existence of larger deposits in the vicinity of the discovery.

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ADDENDA

Since the above communication was written and submitted as information to the New Zealand Department of Agriculture in June, 1936, much progress has been made in the study of the use of cobalt in malnutrition of cattle and sheep in West and South Australia, New Zealand and Florida. It is interesting to note that K. J. McNaught (New Zeal. Jour. Sci. and Technol. 18: 655–661. 1937) has substantiated variations ranging between 5.2 and 281.0 parts per million of cobalt in various samples of limonite taken from Okaihau quarries in New Zealand. His analyses were by chemical methods.

The accompanying paper—"The essentiality of cobalt in bovine nutrition," by Drs. W. M. Neal and C. F. Ahmann in this issue of the JOURNAL OF DAIRY SCIENCE, reviews the literature available at time of submitting the manuscript.

Our thanks are expressed to Dr. B. C. Aston, formerly Chief Chemist of the New Zealand Department of Agriculture, who arranged the exchange of mineral supplements for mutual study. Dr. Aston retired on August 31, 1936, after over forty years of illustrious service in the field of chemistry and nutrition.

THE ESSENTIALITY OF COBALT IN BOVINE NUTRITION

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The investigation of salt sick (nutritional anemia) in cattle has followed the lines of response of animals in the field to mineral supplement (5, 19), the composition of forage from healthy and affected areas (20, 25), the composition of the soils from the same areas (6), a survey to determine the extent of the condition, and controlled feeding trials with cattle.

The feeds used in these trials with the exception of commercial spray-process skimmilk powder, have been produced on affected areas. The use of iron and copper supplement which was successful in most field tests on less restricted rations has given negative response, while the use of cobalt supplement has allowed normal growth. Details of these trials are to be reported.

LITERATURE

The initial use of cobalt to correct a specific nutritional disorder must be credited to Marston (14) and Lines (13), and Filmer and Underwood (7, 8, 27, 28) in Australia. "Coast disease" in sheep in South Australia was cured by the use of limonite, or by the use of Jansen's salt mixture which, among other elements, contained manganese, zinc, cobalt and nickel. Lines (13), in 1935, reported the recovery of two sheep given 1.0 mg. of cobalt per head per day as nitrate, and that they showed improvement within three days.

Filmer (7), in 1933, in writing of enzootic marasmus of sheep and cattle in West Australia stated ". . . enzootic marsmus is due to a deficiency of some mineral necessary for the metabolism of iron . . ." and ". . . the hypothetical mineral is commonly found in association with iron, and that the effective doses of iron compounds depend on the proportion in which the mineral is present in available form." In 1934, Filmer and Underwood (8) reported that 50 grams of limonite daily would cure cattle, that a 0.125 N hydrochloric acid extract of the same amount of limonite (iron-free) would cure also, but that the extracted residue would not.

Underwood (27) found three to eight times as much iron in the livers, kidneys and spleens of affected sheep and cattle as was found in healthy animals, indicating that there was no deficiency of iron. The biologically potent element of limonte was announced in 1935 by Underwood and Filmer (28) as the result of experiments testing the fractions of the iron-free filtrate, and the individual elements of the effective fractions. The final test was the administration of 2.0, 1.0 and 0.1 mgs. of cobalt, respectively, to affected sheep with resultant recovery of condition and gain in weight.

In 1935, Grimmett and Shorland (10) held that iron *per se* was necessary for the prevention of bush sickness in New Zealand but that cobalt and other elements might have a stimulating effect. However, in 1936, Askew and Dixon (1) reported that 4.0 mgs. cobalt per sheep twice weekly was sufficient to prevent the condition. Like amounts of nickel were ineffective. These trials were conducted at Glenhope, Nelson and Morton Mains, Southland on the South Island, New Zealand. The efficacy of soil extracts and other drenches was found to be dependent on their cobalt content, and as little as 0.4 mg. of cobalt per week was effective with sheep.

Cobalt, as well as Reyburn's limonite, was found to be effective at Kahoroa (North Island) by Wall (29), in the treatment of bush sickness when given at the rate of 1.0 mg. per head per day. The opinion was held that elements other than cobalt might be necessary for the absolute control of the condition.

After cobalt was shown to be effective, the New Zealand study was expanded to include the cobalt content of limonites and other drench materials, the effect of top-dressing on pasture plants, and the cobalt content of soils and animal organs. McNaught (16) found 17–96 p.p.m. of cobalt in Ruatangata (Reyburn's) limonite; 5.2–281 p.p.m. in Okaihua limonite depending on the strata; and 7.0 p.p.m. in ferric ammonium citrate which was effective. Ineffective ores were lowest. Bush sick soils contained 0.12, Morton Mains ailment soils 0.39, and healthy soils 0.61 p.p.m. of cobalt extractable with 0.1 N hydrochloric acid.

The method used was that of Kidson, Askew and Dixon (12), which is an adaptation of that of Stare and Elvehjem (26) and depends on the formation of a red complex by cobalt and nitroso-R-salt (Van Klooster's reagent). This same method was used in the following.

A more extended soil study by Kidson (11) showed a variation from 0.3 to 380 p.p.m. of cobalt extractable with concentrated hydrochloric acid. Few soils contained more than 20 p.p.m. unless of basic origin. Most bush sick soils contained less than 2.0 p.p.m. Morton Mains soils contained from 2.8 to 8.3 p.p.m. with no correlation between sick and healthy, and some healthy soils contained less than 2.0 p.p.m. Cobalt content was not considered to be a sufficient guide to determine the use of cobalt supplement.

Askew and Dixon (2) top-dressed pastures with cobaltous chloride ($CoCl_2 \cdot 6H_2O$). They found increases to 6.7 and 74 p.p.m. from 0.20 and 0.24 p.p.m. using 10 and 100 pound applications per acre, respectively, on affected soil. Legumes took up more cobalt than grasses but were less tolerant, phosphate favored uptake, and lime depressed it. Higher applications eliminated weeds and many of the legumes, thus depressing total yield. Cobalt apparently was fixed in the soil complex to some extent.

Askew (3) found the average cobalt content of liver, blood, spleen, kidney and pancreas of the control and cobalt-treated sheep referred to earlier (1) to be 0.05 and 0.11 p.p.m. respectively, on the dry basis. The pancreas was

highest in the control animals and the liver and kidneys in the treated. Dixon (3) found the comparison between controls and treated (average of three animals each) on the dry basis to be as follows: liver, 0.025 and 0.20 p.p.m.; blood, 0.01 and 0.03 p.p.m.; spleen, 0.03 and 0.04 p.p.m.; and pancreas, 0.025 and 0.07 p.p.m. They estimated that there is less than 30 mgs. cobalt in a 100-pound lamb, and that the element is poorly assimilated.

Unpublished results (25) of spectrographic analyses of wire grass (*Aristida* sp.) collected from healthy and salt sick areas in Florida showed no detection of cobalt, using a procedure sensitive to between 1.0 and 10 p.p.m. Since total ash content ranged between 2.0 and 3.0 per cent for most samples, it is doubtful if the dry grass contained as much as 0.15 p.p.m. of cobalt. This figure may be compared with Askew and Dixon's (2) result of 0.1 to 0.24 p.p.m. in forages from bush sick areas. Also, Stare and Elvehjem (26) could not detect cobalt in the organs of healthy animals unless cobalt had been administered, yet Askew and Dixon (3) are able to report values for the element in animals definitely suffering from deficiency.

Becker and Gaddum (4) found 50 p.p.m. of cobalt in Reyburn's (Ruatangata) (effective) limonite spectrographically, while none was detected in Puhipuhi (ineffective) limonite, even after overexposure of the plate.

Previous publications on the use of iron compounds, in which the effective agent was cobalt impurity, are referred to in the above papers and will not be reviewed. The production of polycythemia in experimental animals by the addition of cobalt to a diet already adequate in the element (15, 17, 22, 23, 26, 30) and the reduction of mortality rate in the case of sodium cyanide poisoning (24) indicate some effects of the element. Orton (22) found that the oral and subcutaneous administration of cobalt to rats increases the proportion of reticulocytes, and also the concentration of bilirubin in the serum. The hematopoietic action is one of stimulation.

The effects of a deficiency will be reviewed with the discussion of the experiments to be reported.

EXPERIMENTAL PROCEDURE

The general experimental plan was to feed calves on a ration obtained from affected (salt sick) land and to follow changes in their condition and response to supplemental feeding, by appropriate tests.

Animals were obtained from the Florida Agricultural Experiment Station Jersey herd at birth. The herd is maintained on pasture in season, corn silage, a limited amount of alfalfa hay purchased outside the state, and mixed grain in proportion to production. Bonemeal, salt sick lick (5), and common salt are available at all times. A part of the roughage in the above ration is produced on affected land.

The basal ration was made up of Natal grass (*Tricholena rosea* Nees) hay, shelled corn, commercial spray process skimmilk powder, cod liver oil, and

whole milk. The hay was obtained from a farm where 23 out of 25 head of cattle were lost from malnutrition in a single season. The corn was produced on the Experiment Station farm on fields of the same soil types. Skimmilk was used as a source of protein to balance the ration, and whole milk was fed at the customary time. No cobalt was detected spectrographically (9) in the ash of any of these feeds, even after overexposure of the plates.

The animals were kept in individual stalls with solid partitions and bedded with excelsior waste. They were exercised in a paved concrete lot. Gainesville city water was available in an automatic water cup, except for E–85, E–86 and E–87, given distilled water in aluminum pails for a time. Feeding was twice daily, and in most cases, the offering of hay and corn was based on appetite. Skimmilk was fed after reconstitution, and the corn without grinding, as they were found to be more palatable in such forms. Very few grains of corn were found in the feces. Cod liver oil was supplied at the rate of 20 cc. daily as the hay was of poor color, and the corn was a white variety.

Common salt was available at all times. Mineral supplements were added to the milk as solutions, once daily. Ferric ammonium citrate and copper sulfate solution was tested as a supplement on account of its efficacy in field work with salt sick (5, 19). The use of cobalt was initiated upon receipt of information concerning its use in West Australia in enzootic marasmus (28).

All animals were weighed once weekly and growth curves plotted from moving averages of three weights. This procedure, rather than three-day weights every 28 or 30 days, was followed in order that such changes in body-weight as occur in conditions involving extreme anorexia might be recorded. Losses of as much as 20 per cent have been noted with animals in a single week.

Hemoglobin was determined once weekly by the Newcomer acid hematin method (21) on blood obtained by puncture of the marginal vein of the ear. Curves were plotted from moving averages of three determinations. After such curves failed to show changes concordant with change in condition of the animals, total erythrocyte counts, cell volume determinations, vital stained blood smears for reticulocytes and cell size and shape, and differential leucocyte counts were made periodically on some animals.

General condition of the calves was noted from time to time. Gross pathology was noted at the time of death or slaughter. Histological examination was made of selected organs of representative animals.

<center>RESULTS</center>

Growth curves for seven animals used in this study are presented in Figure 1. Additional animals have been maintained on the same ration with and without the use of iron and copper supplement with similar

results. Only three animals have received cobalt under the conditions of the experiment.
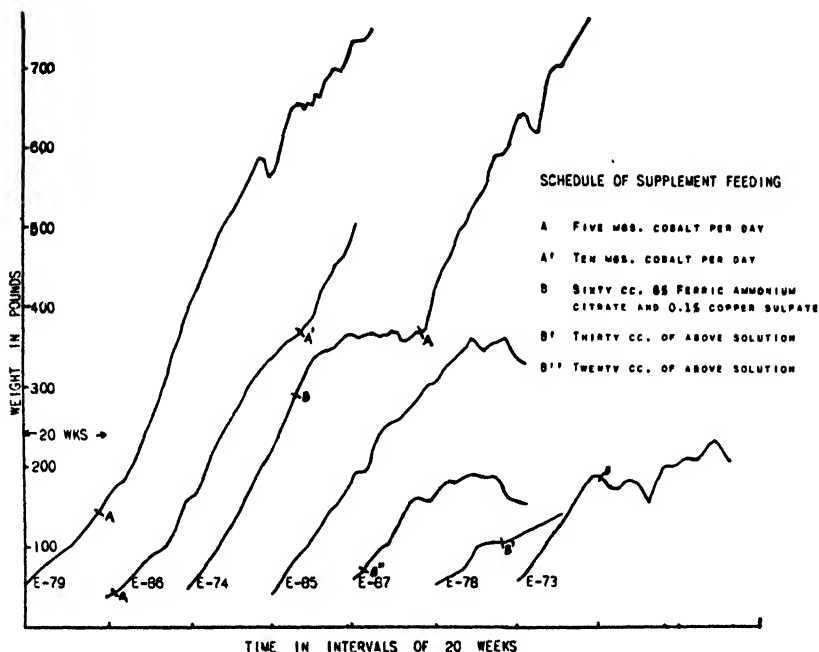
FIG. 1. Growth curves of calves showing the effect of cobalt; iron, copper and cobalt, and iron and copper supplements to a basal ration of Natal grass hay, shelled corn and skimmilk powder, the hay and corn being produced on deficient land.

Animal No. E–85 (male) on the basal ration made satisfactory growth to a weight of 360 pounds. At that point, his intake of hay and corn decreased markedly but he continued to consume skimmilk. He weighed 300 pounds at time of slaughter 15 weeks later and the carcass weighed 116 pounds.

Four calves of this group received the ferric ammonium citrate and copper sulfate solution (6% Fe $(NH_4)_3(C_6H_5O_7)_2$ and 0.1% $CuSO_4$ 5 H_2O) at rates of 20, 30 and 60 cc. per head per day. E–73 (male) was fed the basal ration until 33 weeks of age, and then 60 cc. of the iron and copper supplement was added. His weight decreased, followed by some increase, and then another decrease and death at a final weight of 200 pounds.

A lesser amount of iron and copper supplement (30 cc. daily) was given E–78, a heifer calf dropped by a cow maintained on the basal ration, and pasture in season on marginal land. This calf continued to make slight gains but weakened and died at a weight of 145 pounds when 7½ months of age.

A still lesser amount (20 cc. daily) of the iron and copper solution was

given E–87. He reached a maximum weight of 188 pounds, which dropped
to 140 pounds at the time of slaughter with a dressed weight of 58 pounds.

Animal No. E–74, an Angus-Jersey crossbred female was fed the basal
ration from birth (Dec. 11, 1934) until June 15, 1935, at which time she
weighed 284 pounds. Then, 60 cc. daily of the iron and copper supplement
was given, and seven months later liveweight had increased only 80 pounds
and dry matter intake had decreased from over 7.0 pounds to less than 3.0
pounds per day. Upon the addition of 5.0 mgs. cobalt as cobaltous sulfate
($CoSO_4 \cdot 7 H_2O$), her feed intake quadrupled within four weeks, some re-
sponse being evident within three days, and weight increase was at the rate
of 50 pounds per month until she weighed over 600 pounds. Therefore,
gains were less regular. She conceived to a single service and dropped a
normal calf when two years old.

The first animal given cobalt in an effort to prevent the malnutrition
was E–79, a full brother to E–87. The daily amount was 5.0 mgs., beginning
when he was four months old. He made regular gains until a weight of 550
pounds was reached. From this point, gains were intermittent, but 740
pounds was the final weight before slaughter when 20 months of age. The
dressed carcass weighed 351 pounds.

Cobalt supplementation was started with E–86 when he was four weeks
old. He was a weak calf of 34 pounds birthweight. Weight increase, feed
intake, and appetite were excellent until he was $10\frac{1}{2}$ months old. Failure
of appetite occurred at that age and the cobalt supplement was increased
from 5.0 to 10.0 mgs. per day. Appetite improved immediately and gains
were more rapid than previously. Whether or not the intermittent increases
in weight, as in the cases of E–74 and E–79, will occur later is problematical.

No effect was noted with E–85, E–86 and E–87 from the substitution of
tap water by distilled water.

Photographs of four of the above animals appear in Figure 2.

Affected cattle usually show a long rough coat of hair, scaliness of the
skin, listlessness, retarded development of sexual characteristics, gauntness
due to loss of appetite (much less marked when liquid skimmilk is a part
of the ration), and muscular atrophy. Animals supplied iron and copper
supplement exhibited these symptoms earlier than those on the basal ration,
while animals receiving cobalt, or iron, copper and cobalt appeared normal
in every way.

The results of hemoglobin determinations for the seven animals are
plotted in Figure 3. No correlation is evident between hemoglobin level
and the condition of the animal. No extreme high values indicative of
polycythemia were encountered and neither were there low values as usually
associated with anemia. Oftentimes there apparently was an increase in
hemoglobin level when a calf lost in condition.

FIG 2   Photographs showing effect of supplements to a ration of Natal grass hay, shelled corn and skimmilk powder the hay and corn being produced on deficient (salt sick) land   Left animal in upper pictures E–86, received cobalt while E–85, was on the basal ration   Weight difference was 200 pounds at 15 months   E–74, lower left, received iron, copper and cobalt   E–87, lower right, received iron and copper supplement
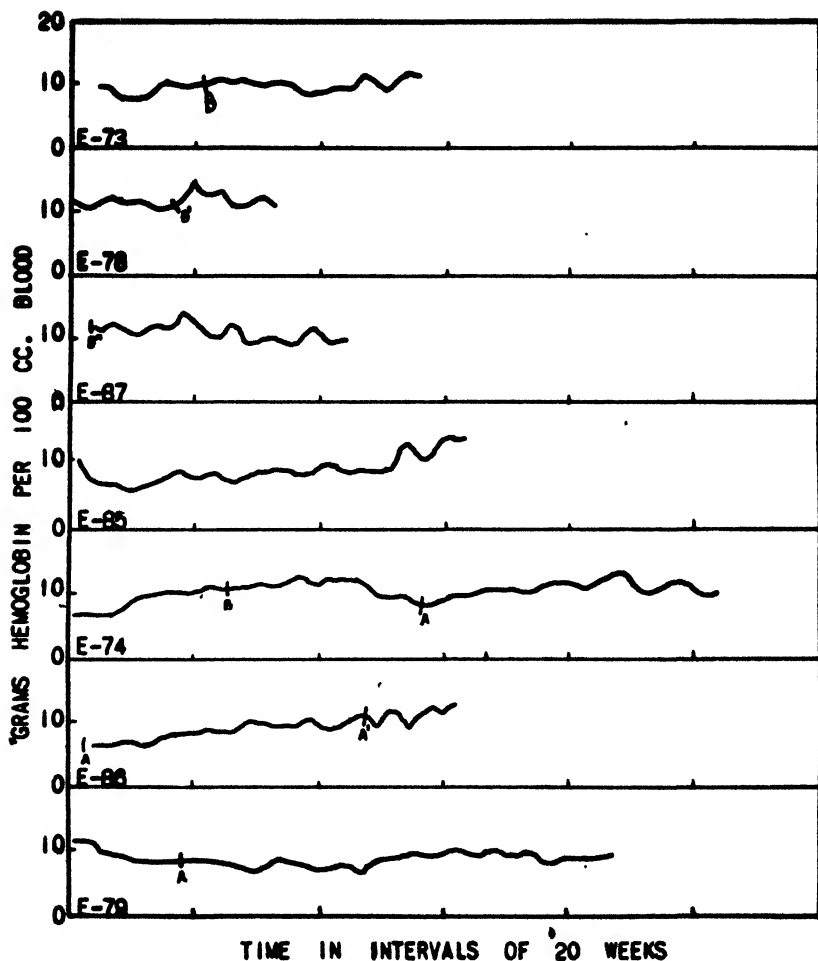
FIG. 3. Hemoglobin curves of cattle fed a ration of Natal grass hay, shelled corn and skimmilk powder, the hay and corn being produced on deficient (salt sick) land. Supplementation was as follows: A, 5.0 mgs. cobalt per day; A', 10.0 mgs. cobalt per day; B, 60.0 cc. iron and copper solution per day; B', 30.0 cc. iron and copper solution per day, and, B", 20.0 cc. iron and copper solution per day. (Iron and copper solution was 6.0 per cent ferric ammonium citrate and 0.1 per cent copper sulfate.)

Total red cell counts gave results between 5.0 and 7.5 million per cmm. E–86, receiving cobalt and making normal growth, usually had a lower count than E–87 receiving iron and copper, or E–85 on the basal ration. In general, the concentration of hemoglobin per cell, and per cell volume, was lower in animals not receiving cobalt. The individual cell was larger when

cobalt was fed. The preliminary data on this phase indicate that the condition is a microcytic hypochromic anemia, even though the hemoglobin levels do not show significant differences.

Vital stained blood smears showed less than 1.0 per cent reticulocytes in all cases, regardless of supplementation. When cobalt was given, the erythrocytes appeared normal, but animals on the basal ration or receiving iron and copper supplement showed antisocytosis and poikilocytosis.

Differential leucocyte counts showed an increase in lymphocytes at the expense of the granulocytes, without significant change in the total number of leucocytes.

The most prominent internal changes are thinness and paleness of musculature, and lack of body fat. The thymus atrophies earlier than normal. The heart is less firm and is lighter in weight than normal but less so than is encountered in field cases of salt sick. The liver is somewhat smaller than average. The spleen is small with a thickened capsule and appears fibrous although the pulpy portion is usually of good color. Gelatinous exudate occurs in the thoracic and abdominal cavities, similar to its occurrence in inanition.

The myocardium shows a very striking degenerative muscle change, which is patchy in distribution. The degeneration occurs in streaks with relatively good muscle immediately contiguous. The relatively good heart muscle has a fibrous or stringy appearance. The spaces between muscle cells are increased. In some areas muscle cells fade out into degenerating connective tissue.

The most outstanding feature of the spleen was an apparent increase in trabeculi, with a decrease in spleenic pulp. The spleen of these animals had undergone a disorganization. The outer zones of the malphigian corpuscles had disappeared. A large portion of the inner zone was ill defined. Only remnants of the periarterial pulp were found. Many erythrocytes were found in the red pulp areas with an occasional basophilic cell. Miotic figures could not be found in sections of any of the spleen. The appearance of the pulpar areas was clear and open.

The most marked change in the liver was noted around the central vein. There appeared to be several stages of liver degeneration; first, deposits of fat in the liver cells; second, atrophy of the hepatic cells around the central vein; third, accumulation of pigment granules in the cells, and fourth, dilated capillaries. Another stage was the entire disappearance of hepatic cells in circumscribed areas leaving only blood vessels and connective tissue. In other areas there was a marked increase in connective tissue associated with atrophy of the liver cells.

The glomeruli of the kidney were evenly distributed and of approximately equal size. Epithelial cells have clear spaces (on basement membrane side) suggesting cellular edema. The blood vessels show edema of the adventia and to a lesser extent in the media.

Heart, liver and spleen of E–79, the only cobalt treated animal slaughtered, appeared normal both grossly and microscopically.

DISCUSSION

The results of these trials indicate very clearly the beneficial effect of a cobalt supplement to the basal ration, and the deleterious effect of ferric ammonium citrate and copper sulfate. It is felt that the iron *per se* did not have its effect directly, but more probably through depressing the utilization of the infinitesimal amount of cobalt present in the ration. Nor is it felt that the small amount of copper sulfate had any effect as one calf (18) has been fed over six times as much copper (as $CuSO_4$) on the same basal ration with no external effect beyond that of the ration. Also, another animal on a ration of alfalfa had and shelled corn has received 1 5 mgs. copper (Cu) per pound live-weight per day for 15 months without external effect. The effectiveness of the cobalt supplement when added to the iron and copper supplement in the case of E–74 is further evidence against any theory of direct toxicity of iron and copper when used with the basal ration.

The most striking effect of the use of cobalt is its effect on appetite An animal receiving cobalt would consume several times as much Natal grass hay, that was little better than sample grade in appearance, as another of the same weight not receiving cobalt. This supports the theory of the authors that the palatability of any constituent in the ration depends on the adequacy of the entire ration.

It is difficult to find any specific gross external, or internal, symptom of cobalt deficiency. Roughness of hair coat, loss of appetite, listlessness, retarded development, and emaciation are encountered in a variety of malnutritions. The blood picture is similar to that reported by Filmer (7) in which anisocytosis and poikilocytosis, and an increase in the proportion of lymphocytes were noted. No reticulocytosis has been noted in our experience, or in Filmer's. These changes are typical of anemia.

Pigment deposition (hemosiderosis) has been noted by Filmer (7), and also in the affected cattle in these experiments, in the liver and spleen. Underwood (27) noted increased amounts of iron in the liver, kidney and spleen. Fatty changes have been present in the liver in both cases, and liver fibrosis has been noted in this instance. The heart has showed myocardinal degeneration and fibrous infiltration. None of these effects were noted in E–79, the only animal slaughtered after receiving cobalt.

Analytical data as to the level of cobalt in healthy and affected animals is of questionable diagnostic value since methods must be of extreme sensitivity. Spectrographic analysis (25) has not demonstrated the occurrence of cobalt in forage known to have an adequate amount. Chemical methods require many manipulations and reagents, and are too largely dependent on the human equation. In localities where positive response to cobalt has been

secured, it is possible to eliminate other etiological factors, and expect beneficial effects from the use of the element.

The tendency in regard to mineral elements in nutrition has been to restrict consideration to those elements known to be essential. A more valid viewpoint is to make such consideration on the basis that all the elements are essential in greater, or lesser, amounts; that too great amounts may be toxic, and that the ratio of one mineral element to another, and also to the organic nutrients, is of equal importance with absolute amounts.

The specific symptoms that may be expected with a deficiency, or excess, of any element or compound are dependent on the ratio of that element or compound to all others in the ration. This fact explains the inconsistencies that occur between different animals, and animals in different localities. An exact duplication of conditions is never achieved because of the large number of variables, and this must be considered in all interpretations.

The form of the element is of great importance. It is improbable that a 1000-pound cow contains as much as 25–30 mgs. cobalt. A day's intake of cobalt in normal feeds is not over 1.0 to 2.0 mgs., yet in the case of one animal an additional response was secured by increasing the daily supplement to the basal ration from 5.0 to 10.0 mgs.

Salt sick in Florida may better be considered a generic term denoting a group of conditions with similar external symptoms. "Hill sick" is the particular term used in areas similar to those where the hay and corn used in the ration in these experiments were produced. Elements other than iron, copper and cobalt may be involved in the etiology of salt sick in various areas. With elements necessary in such small amounts, their indispensability can be determined only under conditions in which their addition to the ration gives beneficial effects.

SUMMARY

A malnutrition has been produced in calves that is prevented or cured by cobalt supplementation and is aggravated by the use of iron and copper supplement.

Appetite failure and accompanying effects on growth are most prominent. The probable non-specificity of the symptoms is considered. Indications that the condition is a microcytic hypochromic anemia are presented.

Differences between the condition and other conditions amenable to cobalt supplement are explained on the basis of other variables.

The small amount of cobalt in normal rations, and the difficulty of measuring such amounts, are stressed. Biological response is given as the sole diagnostic method at the present time.

Martin in preparation of histological sections, and of Herbert and A. L. Henley, Arvin Pierce and D. C. Nearpass, who fed the calves used in this study.

ADDENDA

Since the preparation of this manuscript, Underwood's (Underwood, E. J., Cobalt content of iron compounds and its possible relation to treatment of anemia. Proc. Soc. Exp. Biol. and Med. 36: 296–299. 1937) analyses showing 0.4 to 41.0 p.p.m. of cobalt in various iron compounds have been received. Also, Kato has reported before the American Pediatrics Society that 55 children given ferric ammonium citrate at the University of Chicago Medical School Clinic, only 9 responded to the iron alone while 42, or 76 per cent, responded to iron and cobalt with 4 responding to neither.

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THE EFFECT OF USING TRYPTONE–GLUCOSE–SKIMMILK AGAR AND 32° C. INCUBATION ON THE BACTERIAL COLONY COUNT OF ICE CREAM*

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One of the media which has been proposed to replace standard nutrient agar for the plating of milk as specified in Standard Methods of Milk Analysis (1) is a tryptone-glucose-skimmilk agar developed by Bowers and Hucker (2). Another change under consideration is the lowering of the 48-hour incubation temperature from 37° to 30° or 32° C. Breed (3) has reviewed the history of Standard Methods with special reference to the agar medium and the incubation temperature.

Mudge (4) in 1927 suggested an incubation temperature of 30° C. for 48 hours and pointed out that larger colonies and higher counts could be obtained at this temperature than at 37° C. Pederson and Yale (5) in 1934 confirmed the above and brought out two other important points in favor of the lower temperature of incubation. First, they showed that temperature variations in incubators operating at 30° to 32° C. caused less error than in incubators operating at 37° C. Second, the 32° C. count was a more constant proportion of the maximum 48-hour count than was the 37° count.

Later, Yale and Pederson (6) determined that 30° to 32° C. was also the optimum temperature range for the incubation of tryptone-glucose-skimmilk agar plates prepared from pasteurized milk. Maximum counts in the case of raw milk were usually obtained at temperatures slightly below 30° C. Study of a limited number of samples of ice cream (5) suggest that the optimum 48-hour incubation temperature for agar plates is somewhat lower than for milk and is probably between 25° and 30° C.

Extensive comparisons by other investigators, *i.e.*, Kelly (7), have established the fact that tryptone-glucose-skimmilk agar plates incubated at 32° C. more nearly indicate the true bacterial content of dairy products, especially those inferior in quality than do standard nutrient agar plates incubated at 37° C.

The bacteriological quality of ice cream is receiving increasing attention. Ice cream is a product which may contain quite a different bacterial flora from market milk, due largely to its higher sugar content, higher pasteurization temperature, variety of ingredients and low storage temperatures, both of cream used in manufacture and of the finished product.

Fabricius and Hammer (8) recognized the presence of saccharophilic types and recommended addition of one per cent sucrose to standard agar, a procedure which resulted in larger colonies and increased counts. Babel (9) compared standard nutrient agar, standard nutrient agar plus one per cent sucrose and tryptone-glucose-skimmilk agar counts on 192 samples of commercial ice creams. Tryptone-glucose-skimmilk agar gave higher total counts and colonies of greater size than did the other two media while standard nutrient agar plus sucrose was superior to standard nutrient agar. These comparisons were carried out at 37° C.

Robertson (10) summarized comparative data on 412 samples of ice cream and ice cream mixes collected by 5 ice cream companies in which standard agar and tryptone-glucose-skimmilk agar plates were incubated at both 37° and 32° C. Lowering the temperature of incubation from 37° to 32° C. had a greater influence on the counts than changing the medium from standard to tryptone agar. Expressing the average 37° standard agar count (logarithmic basis) as 100 per cent, the 37° C. tryptone agar count was 116 per cent, the 32° C. standard agar count 137 per cent and the 32° C. tryptone agar count 154 per cent.

Yale and Hickey (11) studied the bacteriological quality of the ice cream supply for a small city in which no bacteriological standards for ice cream were fixed or bacteriological control established. Data are presented in this publication showing comparative standard nutrient agar plate counts at 37° C. and tryptone-glucose-skimmilk agar plate counts at 32° C. on 112 store samples of ice cream representing 12 manufacturers. Approximately one-half of the samples were taken aseptically from opened cans while the remainder were taken with the vendor's dipper. The purpose of this present paper is to discuss data collected in the same study which permit comparisons of counts to be made.

Single plates were prepared in dilutions of 1:100, 1:1,000, 1:10,000 and in some instances 1:100,000 on standard nutrient agar and on a tryptone-glucose-skimmilk agar of the following composition:

Bacto Tryptone-Glucose Agar	21.0 grams
(Agar 15 gms., tryptone 5 gms., glucose 1 gm.)	
Distilled water	1,000 ml.
pH 6.6	

The above ingredients were dissolved in distilled water by boiling, 5 ml. of sterile skimmilk added, the mixture dispensed in flasks in 200 ml. quantities and sterilized at 20 pounds for 15 minutes.

RESULTS OBTAINED

Logarithms tend to minimize small differences which might otherwise be considered significant and permit the presentation of large groups of data

in a small space. Safford and Stark (12) and (13) plotted logarithms to show the relation between counts on standard agar and counts on improved agars. A similar form of graph, but one in which dots were not connected with the diagonal line, was employed in the present study.

Figure 1 shows graphically the results obtained with 112 store samples of bulk ice cream taken in Geneva during the summer of 1936.
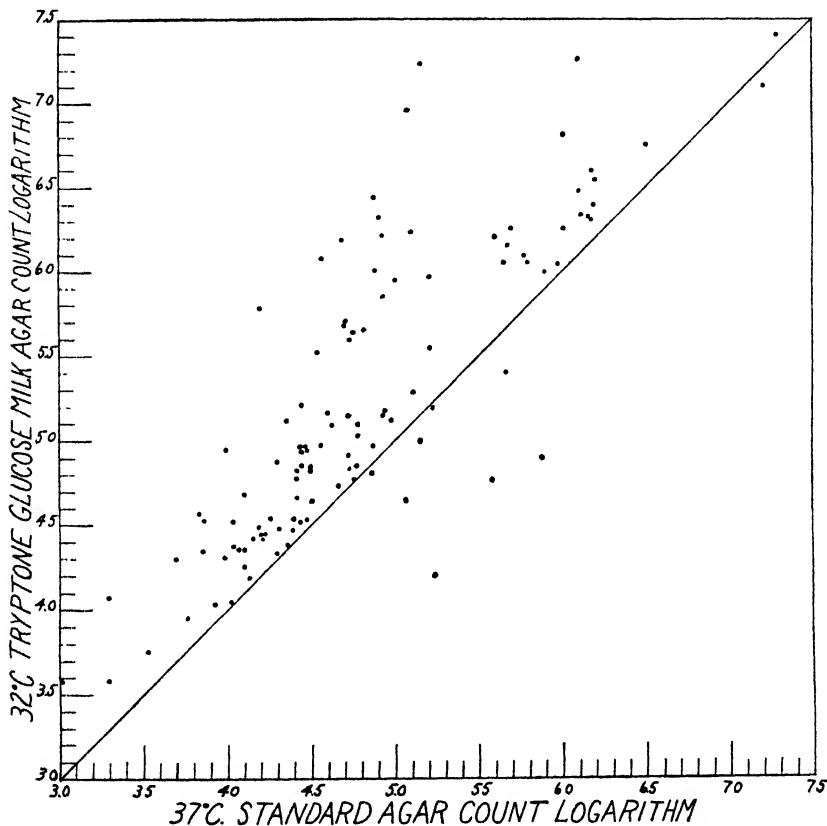
Fig. 1. Logarithms of 37° C. standard nutrient agar counts and of 32° C. tryptone glucose milk agar counts for 112 store samples of ice cream representing 12 manufacturers.

Logarithms of standard agar counts are plotted on the diagonal line. If the tryptone agar count exceeds the standard agar count, its logarithm appears above the diagonal line and vice versa. The distance vertically from each dot to the diagonal line represents a single logarithmic difference. Each dot represents a single tryptone agar count.

It is evident (Fig. 1) that the great majority of the tryptone agar counts exceeded corresponding standard agar counts and that (2) the extent of the

increase was highly variable. In 103 instances out of 112 (92.0 per cent), tryptone agar counts were higher than corresponding standard agar counts.

In comparing the quality of ice cream of individual manufacturers, the logarithms of individual counts have been averaged and converted to equivalent antilogs (Table 1).

TABLE I

Comparative quality of ice cream of 12 manufacturers based on logarithmic averages of standard agar and tryptone agar counts of 112 store samples

MANUFAC-TURER	NUMBER STORE SAMPLES	AGAR PLATE COUNT				PERCENT-AGE DIFFER-ENCE
		Standard agar (48 hrs. at 37° C)		Tryptone agar (48 hrs at 32° C.)		
		Logarithmic Ave. of counts	Antilog	Logarithmic Ave. of counts	Antilog	
A	8	4.42609	26,700	4.55195	35,600	33
B	7	4.26786	18,500	4.66460	46,200	149
C	9	4.71674	52,100	4.82037	66,100	27
D	10	4.69552	49,600	5.08145	121,000	143
E	9	4.40887	25,600	4.96213	91,700	258
F	11	5.04345	111,500	5.44729	280,000	154
G	11	4.74271	55,300	5.22398	168,000	203
H	8	4.09388	12,400	4.35819	22,800	84
I	11	4.93291	85,700	5.34539	222,000	158
J	6	5.27843	190,000	5.13127	135,000	− 29
K	12	5.10809	128,000	6.22925	1,700,000	1,221
L	10	5.81341	651,000	6.25075	1,780,000	174
Average		4.7764	59,800	5.1949	157,000	162

Theoretical standard agar count averages (antilogs) in the case of the 12 manufacturers ranged between 12,400 per gram and 651,000 per gram and tryptone agar averages between 22,800 per gram and 1,780,000 per gram. Standard agar averages were less than 100,000 per gram in 8 instances, between 100,000 and 200,000 per gram in three instances and over 200,000 per gram in one instance. Tryptone agar averages were less than 100,000 per gram in 5 instances, between 100,000 and 200,000 per gram in 3 instances and over 200,000 per gram in 4 instances. Using an arbitrary standard of 100,000 per gram, the ice cream of 4 of the 12 manufacturers was unsatisfactory when based on standard agar counts as compared to 7 manufacturers when based on tryptone agar counts (Table 1).

The theoretical percentage increase in the average tryptone agar counts over the average standard agar counts varied from minus 29 to plus 1,221 per cent, but with the exception of the above extremes, increases ranged between 27 and 258 per cent. The proportion of the total number of colonies capable of developing varied greatly with standard agar at 37° C. Obviously, this renders standard agar at 37° C. a poor instrument for measurement of quality since poor quality may masquerade as good quality ice cream. To illustrate, manufacturers C and G had average standard agar

counts (logarithmic basis) of 52,100 per gram and 55,300 per gram respectively, indicating ice cream similar in quality which would easily meet a standard of 100,000 per gram. That the ice cream of manufacturer C was really within the 100,000 standard while that of manufacturer G really failed to meet this standard is indicated by average tryptone agar counts of 66,100 per gram and 168,000 per gram respectively (Table 1).

The antilog of the average of logarithms of the counts of all samples was 59,800 in the case of standard agar, and 157,000 in the case of tryptone agar. The percentage difference of 162 per cent in favor of tryptone agar and 32° C. incubation is significant in consideration of the fact that it is based on logarithmic averages.

SUMMARY

A comparison between 37° C. standard nutrient agar counts and 32° C. tryptone-glucose-skimmilk agar counts on 112 samples of ice cream representing 12 manufacturers was made on a logarithmic basis.

Tryptone agar counts were higher than standard agar counts in 103 instances (92.0 per cent). The theoretical average percentage increase in the case of individual manufacturers varied from minus 29 to plus 1,221 per cent, but with the exception of these extremes, increases ranged between 27 and 258 per cent.

The fact that the proportion of the number of colonies developing on tryptone agar at 32° C. varied so greatly from standard nutrient agar at 37° C. indicates that the latter is a poor instrument for use in quality measurements and shows that poor quality may masquerade as good quality ice cream, where the present standard method of making agar plate counts is followed.

Wide distribution of the dots in Fig. 1 shows clearly that the number of colonies on standard agar plates incubated at 37° C. does not represent a constant proportion of the total number capable of development.

Based on the entire 112 samples, the average percentage increase in count of 162 per cent in favor of tryptone agar and 32° C. incubation is highly significant in consideration of the fact that it is based on logarithms.

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RECOMMENDED UNIFORM RULES FOR THE HERD IMPROVEMENT REGISTRY TEST

The purpose of the Breeds' Relations Committee in making the following recommendations was to simplify, without detracting from the reliability of the test, the rules for the Herd Improvement Registry Tests. State Superintendents of Official Testing are faced with the problem of explaining five dairy breed herd tests to supervisors and breeders. Building on the experience of the breed association and the state superintendents, the committee was of the opinion that a revision of the rules was possible and that a uniform set of rules for all breeds would strengthen this vitally important testing program.

A revision and supplement to the rules was recommended by the Breeds' Relations Committee and adopted by the American Dairy Science Association at Ames, Iowa, June, 1930. It was recommended by the Breeds' Relations Committee of the American Dairy Science Association at a meeting of the committee held at Dallas, Texas, October 13 and 14, 1936, and adopted by the Production Section of the American Dairy Science Association at its annual meeting held June 25, 1937, at Lincoln, Nebraska.

The following are the recommendations:
Entering herds on test.

Any owner of registered cattle of a dairy breed may make application at any time to the National Breed Association concerned to enter his herd on test, using the forms furnished by the breed association.
Identification of cows on test.

All cows on test must be identified by tattoo number or by color sketches on broken colored animals. The day, month and year of birth must be reported.
Conduct of test.

The herd test may be started at the first of any calendar month. Twelve consecutive periods of 24 hours, approximately one month apart, with or without preliminary milkings shall be required during the testing year, retests and surprise tests not to be included. Credits for milk shall begin with the fourth day after calving but no butterfat test shall be made before the seventh day. The day on which the calf is dropped is counted as the first day.
Cows to be tested.

All registered cows as long as in the herd. (See cows omitted from test.)
Cows to be omitted from test.

The following exceptions from testing may be made:
1. Cows 12 years old or over with A. R., R. O. M., R. O. P., or H. I. R. records.

2. Cows used as nurse cows throughout the lactation period having one or more A. R., R. O. M., R. O. P., or H. I. R. record meeting A. R., R. O. M., or R. O. P. requirements.

3. Cows whose registration certificates are surrendered for cancellation before the 11th month of the Herd Test year.

Requirement of milk weights.

The requirement of daily milk weights is optional.

Number of cows milked at one time.

Not more than two cows may be milked at one time, except where a combine milker is used and then not more than four units of one section may be operated by one attendant only.

Times daily cows may be milked.

Not more than three milkings per day may be permitted.

Number of cows which may be supervised per day.

Thirty cows, or if individual samples are taken, a maximum of 60 milkings may be supervised by the tester.

Samples to be tested.

Composite samples but not in duplicate. Individual samples may be permitted.

Retests.

Automatic retests are to be required when 60 days after freshening cows exceed the following daily butterfat production:

	Lbs. fat in 1 day
Mature cows	3.0
Senior 4 years old	2.9
Junior 4 years old	2.8
Senior 3 years old	2.6
Junior 3 years old	2 4
Senior 2 years old	2.2
Junior 2 years old	2.0

All retests are to be made at the owner's expense.

Surprise Tests.

One or more surprise tests with a preliminary milking shall be made by a different supervisor during the testing year. The first test is to be at the owner's expense, others at the breed association's expense.

Owner's requested retests.

The herd owner may request a retest by notifying the state superintendent of official testing within 72 hours of the close of the original test. All cows in the herd must be included in the test and at the expense of the owner.

Report blanks.

The American Dairy Science Association Herd Test Report Blanks are to be used to report the tests.

Yearly herd average.

In calculating yearly herd averages the production of all registered first calf heifers that have been in milk ten or more months of the herd test year and all registered cows that have ever freshened and that have been owned in the herd ten months or more of the herd test year, shall be included in the herd average.

In reporting herd averages, a supplementary list shall be furnished giving all heifers and new cows in the herd less than ten months with their production.

Dishonest or fraudulent practice.

If the state superintendent of testing is satisfied that fraudulent or dishonest practices have been used in making of herd test records of registered cows, he shall report report same to the breed association which may reject or cancel such records.

Matters not covered by rules.

Details of supervision which these rules do not specifically cover shall be administered by the state superintendent of official testing.

Revision of rules.

Any revision of the rules shall be made by a joint committee of the breed associations and the American Dairy Science Association. The chairman of the Breeds' Relations Committee shall be *ex-officio* chairman.

Committee:

S. M. SALISBURY, Ohio —*Chairman*

C. N. SHEPARDSON, Texas

C. E. WYLIE, Tennessee

R. T. HARRIS, Wisconsin

J. G. HAYS, Michigan

EARL N. SCHULTZ, Iowa—*Secretary*

* A revision of this rule was referred back to the committee by the Production Section.

AMERICAN DAIRY SCIENCE ASSOCIATION PRESENTED BORDEN AWARDS TO L. A. ROGERS AND C. F. HUFFMAN

President R. R. Graves at 11 : 00 A.M. on June 25, 1937, before a group of members and friends said, "We come now to a very important part of our program, that of the presentation of the Borden Awards.

I would like Dr. Ellenberger, Dr. Hunziker, and Mr. Wentworth to come to the platform.

Last fall the Borden Company announced that it would present six prizes or annual awards of $1000 in cash and a gold medal for meritorious work in science as it is related to the dairy industry. These awards were to be made in the following branches of science:

1. For work in the production field, breeding or feeding of dairy cattle, farm sanitation or quality production, etc., to be administered by the American Dairy Science Association.
2. For work in the processing field, such as improvement in equipment or methods in the handling of milk or cream and the production of milk products, to be administered by the American Dairy Science Association.
3. For work in the basic science as it is related to, or affects, the dairy industry, to be administered by the American Chemical Society.
4. For work in basic research on vitamins or other nutritional aspects of milk products, to be administered by the American Association for the Advancement of Science.
5. For work in the practical application of the findings in nutritional research, to be administered by the American Home Economics Association.
6. For work in public health as it is related to the milk industry, to be administered by the American Public Health Association.

As will be noted, the American Dairy Science Association was asked to administer the awards for work in the production field and for work in the manufacturing field. Your officers and directors thought that these awards would be a stimulus for greater effort in research for the dairy industry, that they would help to bring recognition and honor to those who were doing outstanding work in the advancement of our industry, and that our association would be glad to administer the two awards in the production and manufacturing fields.

Our Association has not heretofore administered such awards, so that we had no experience of our own to guide us in the formulation of the rules and regulations that were to govern the awards. The Borden Company left the matter of rules and regulations governing the awards entirely to the judgment of the American Dairy Science Association. We first decided that any living citizen of the United States or Canada, of either sex and of any

age, who had accomplished outstanding work for advancement of the dairy industry, would be eligible for the award. In making these rules we recognized that they would be subject to change in subsequent years as experience and practice might indicate.

The members of our board were not in accord as to the nature of the work that should be recognized in considering recipients for the awards. Some felt that a man who had bred and developed an outstanding herd of dairy cattle should be eligible for consideration; that a man who had made a conspicuous success as an administrator of a dairy enterprise, as an editor of a dairy journal, as an organizer of dairy associations or other dairy organizations, or as an inventor of dairy equipment or machinery, should be eligible for consideration. It was finally decided, however, that while accomplishments along these and other lines were meritorious and worthy of consideration, it would be difficult in many cases to measure the extent to which an individual was responsible for the success of a given enterprise; that it would be very difficult for an awards committee to weigh many of these rather intangible accomplishments against another; and that it would be best because of the shortness of time in which we had to work, this year at least, to restrict the nominations for consideration to those who had published the results of their research work during the 5-year period ending December 31, 1936. Nomination blanks together with a letter of instructions and invitation, to send in nominations of those considered worthy of the award, were mailed to each member and also printed in the Journal.

It appears to be the experience of other societies in administering such awards that it is difficult to get nominations from the membership, of all of those who are worthy of consideration. Consequently, we appointed two nominating committees, one for the production award and one for the manufacturing award. The duties of the nominations committees were to receive the nominations made by the members, from the secretary's office, and to canvass the field in order to see if any men who had accomplished outstanding research work had failed to receive a nomination, and in that case to put in a nomination for such person or persons. The production nominating committee consisted of the present and the past two chairmen of the Production Section, namely, Professor P. W. Atkeson of Kansas, Professor K. S. Morrow of New Hampshire, and Professor C. Y. Cannon of Iowa. The manufacturing nominations committee likewise consisted of the present and the past two chairmen of the Manufacturing Section, namely, Professor P. H. Tracy of Illinois, Professor L. M. Thurston of Florida, and Professor M. J. Mack of Massachusetts.

After completing their work the nominations committees were to turn over to their respective awards committees the list of nominations and data pertaining to the work of the nominees.

In selecting the members of the two awards committees, an effort was made to secure men who had had experience in evaluating research work, men who knew the problems of the industry, and men who were so well known that the results of their work on these committees could not be questioned. I think the membership of these two committees met those qualifications to an unusual degree. The membership of the manufacturing awards committee was as follows: Dr. H. A. Ruehe, Chairman of the Dairy Husbandry Department, University of Illinois, Chairman: Dr. H. L. Russell, former dean of the College of Agriculture of the University of Wisconsin and director of the Wisconsin Experiment Station and now director of the University of Wisconsin Alumni Foundation; and Dr. O. F. Hunziker, formerly professor of dairy husbandry at Purdue University and now director of research and manager of production of the Blue Valley Creamery Company. The production awards committee included the following men: Dr. H. B. Ellenberger, Head, Department of Animal and Dairy Husbandry, University of Vermont, Chairman: Dr. C. W. Larson, formerly professor of dairying, Pennsylvania State College, and later chief of the Bureau of Dairy Industry, U. S. Department of Agriculture, and now President of the Whiting Milk Company of Boston, Massachusetts, and Mr. E. G. Woodward, formerly professor of dairy husbandry of Washington State College and now a breeder of Guernsey cattle, and also the Dairy and Food Commissioner of Connecticut.

We are fortunate in having with us today Mr. W. A. Wentworth to represent the Borden Company in this ceremony. It is particularly fitting that Mr. Wentworth can present the awards for the Borden Company, for I understand that the presentation of awards by the Borden Company for outstanding work in research on problems affecting the dairy industry, is Mr. Wentworth's idea. Mr. Wentworth is in charge of Public Relations for the Borden Company. After his graduation from Iowa State College in 1910 he was affiliated with the Bacteriology Department of the Michigan Agriculture College. Shortly after this he left research work to operate a dairy herd in Iowa. From managing a dairy farm he was drawn into county agent work from where he became interested in the work of the Dairy Council. In 1923 he went to Ohio where he became Secretary of the Ohio Dairy Products Association leaving the work in 1929 to join the Borden Company.

I am going to ask Dr. Ellenberger, Chairman of the Production Awards Committee, and Dr. Hunziker, of the Manufacturing Awards Committee, to present to you the men that their respective committees have selected for these honors. Mr. Wentworth will present the prizes to the winners, and following that we have asked the recipients of the awards to tell us something of their work and to give us their intepretation of the application of their work, to the industry.''

C. F. HUFFMAN

President Graves then introduced Dr. H. B. Ellenberger, Chairman of the Nominating Committee of the Production Section, who said in part, ''It is a pleasure to report briefly on the work of the awards committee for the Borden prize for meritorious research in the field of dairy production. Other members of this committee are Dr. C. W. Larson, former Chief of the Bureau of Dairy Industry and E. G. Woodward, Connecticut Dairy and Food Commissioner.

This committee gave careful consideration to all who were nominated for this honor, in accordance with the rules, restrictions and methods layed down for its guidance. Its decision has the official approval of this Association.

The man who is to receive this award has through early associations, experience, education, perseverance, and accomplishments attained an enviable position in his chosen field of study and research.

Born on a farm in this wide plains country he has had intimate contact from early childhood with problems incident to the production of plants and animals. He worked his way through college from which he graduated in dairying in 1917, then entered the air service of his country until 1918.

He has had varied practical experience on dairy farms in Florida, Indiana, and Minnesota and has showed cattle at various state and national dairy shows. He has served under and worked with such teachers and investigators as J. B. Fitch, C. H. Eckles, O. E. Reed, E. L. Anthony, and G. Bohstedt.

His major contributions to research are in the field of dairy cattle nutrition dealing particularly with mineral metabolism and requirements. He and his associates have shown that dairy cattle do not suffer from a lack of calcium providing palatable roughages are fed in liberal amounts, also that the use of some mineral supplements may injure rather than benefit. He has demonstrated the fallacy of feeding high-priced complex mineral mixtures.

They have developed much information as to phosphorus requirements and under what conditions it may be deficient. He has carefully studied in much detail the usefulness and economy of home grown roughages. From these researches and others which time does not permit me to mention he has evolved new plans of feeding procedure which insure an ample supply of essential minerals, increased and better usage of home grown roughages that furnish needed nutrients at lowest cost and more efficient and economical production without unnecessary expenditure for supplements.

Presently he will tell you more about his work. I refer to Dr. Carl F. Huffman of Michigan.

Mr. Wentworth, I present Dr. C. F. Huffman for the Borden Award for meritorious research in dairy production. Dr. Huffman is a man of striking and sterling personality and character, a teacher and research leader much loved by his students and associates, a prodigious worker, unafraid to explore

new fields, not deterred by criticism, fertile minded, the center for the conception and direction of many research projects, the keen interpreter of data derived therefrom, an ardent advocate of sound basic ideas, the possessor of unusual ability to foresee and present in a clear understandable manner their application to the problems of the practical dairyman, and withal richly meriting the honor conferred with this award.''

President Graves introduced Mr. O. F. Hunziker who made the following remarks:

''Mr. President, Mr. Wentworth, Officers, Directors, Members and Friends of the American Dairy Science Association: Your Committee on Borden Award for outstanding achievement in the field of scientific research devoted to the manufacture of dairy products, has diligently scanned the luminous firmament of stars and constellations of stars among the brotherhood of dairy scientists. From first to last, from horizon to horizon of the 'Milky Way,' there has stood out, and there is standing out, one great and humbly blinking astral body, the brilliancy and quality of which assign to it a magnitude, and place it in a class, all of its own.

That star among the men of our profession is no stranger to any one engaged in dairy research. His work, both past and present, is recognized as distinguished and outstanding, and his achievements of exceptional scientific merit and his contributions of practical usefulness to the industry, are acclaimed from Ocean to Ocean and in every land that fosters the husbandry of the dairy cow and her product.

This great scientist of whom I am speaking, this leader in dairy research who is the unanimous choice of our Award Committee, the man whom we are proud to recommend as the most deserving candidate for the distinguished Award so generously offered by the Borden Company, is our own Dr. L. A. Rogers, Chief of the Research Laboratories of the Bureau of Dairy Industry, United States Department of Agriculture.

Dr. Rogers graduated from the University of Maine with the Degree of Bachelor of Science. He did graduate work in bacteriology and botany at the University of Wisconsin. He was Assistant Bacteriologist at the New York (Geneva) Agricultural Experiment Station. Since 1902 Dr. Rogers has been in charge of dairy research of the Bureau of Dairy Industry, first as bacteriologist of the Dairy Division and later as Chief of the Research Laboratories of the Bureau. In 1925 the University of Maryland conferred upon him the honorary degree of Doctor of Science and in 1925 his own Alma Mater honored him with the degree of Doctor of Science.

In 1927 the Association and Co-workers of Rogers presented him with a book, prepared by them, and entitled 'Fundamentals of Dairy Science.' This treatise embraces the results of the extensive research work done by Dr. Rogers and by his Associates under his direction. This book is recognized as a masterwork among the literature of dairy science. It is dedicated to Dr. Rogers with the following inimitable inscription and tribute:

To

LORE ALFORD ROGERS

In recognition of his quarter-century service in the advancement of knowledge, embracing important contributions in pure science as well as its applications to industry; and because he embodies in the highest degree their ideal of unselfish devotion and untiring loyalty, alike to his work and to his fellow workers—this volume is dedicated with admiration and affection, by those who have been privileged to serve under his leadership.

Aside from his valuable contributions to pure science, in the fields of bacteriology, chemistry and physics, Dr. Rogers has made countless important contributions of outstanding merit and usefulness to the dairy industry. His keen insight, his sound judgment, his rare genius and his indefatigable industry have brought forth discoveries and inventions of new and improved apparatus and equipment, new and improved methods of manufacture, new dairy products and improved quality of established products. These achievements have served to augment the profitable returns from the product of the dairy cow, for the lasting benefit of the industry and the consumer alike.

His discovery that butter made from pasteurized sweet cream had better keeping quality than butter made from sour, ripened cream, has revolutionized the theory and practice of butter manufacture and has saved the industry millions of dollars through prevention of quality-damaging flavor deterioration in storage and out.

His directions for the manufacture of marketable concentrated sour milk products have provided added avenues for the profitable disposition of surplus milk and surplus milk by-products.

His extensive studies of the causes of damaging age-thickening and of the development of fungus growth in sweetened condensed milk have supplied the knowledge and the means to preserve the quality and the market value of this dairy product when held in storage.

His researches on the heat coagulation of evaporated milk have been instrumental in improving the process and in eliminating costly losses in the manufacture of this important dairy product, the annual output of which runs into billions of pounds.

His work on Roquefort cheese has demonstrated the feasibility of the commercial manufacture of domestic Roquefort cheese of good quality from cows' milk.

His profound penetration into the mysteries of the bacteriology of Swiss cheese has paved the way to the development of an improved method for the manufacture of domestic Swiss cheese of high quality and dependable digestibility.
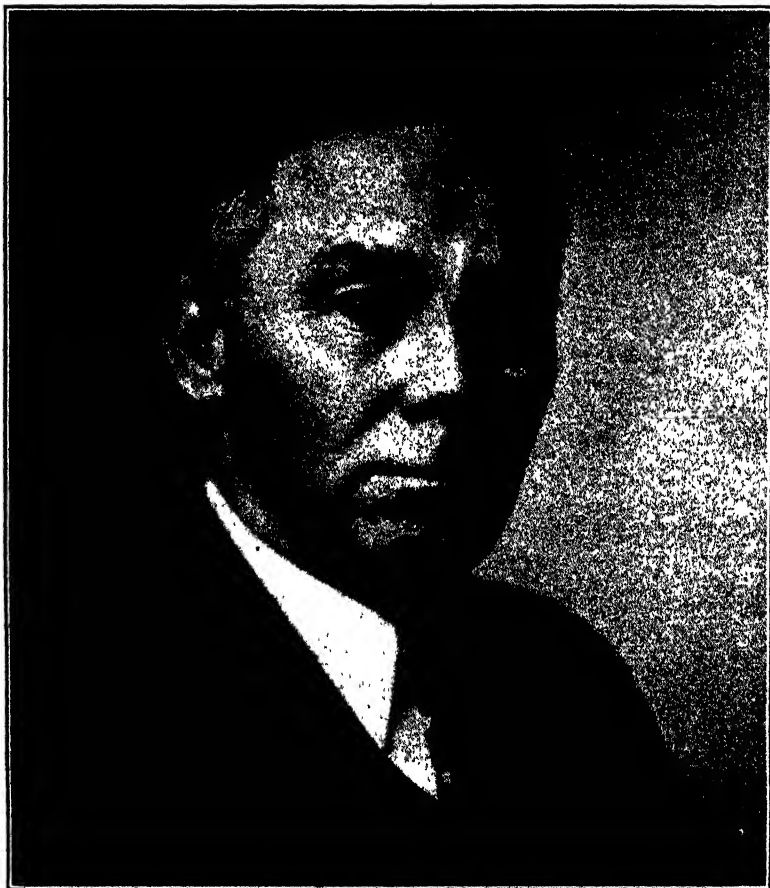
LORE ALFORD ROGERS

His invention of the valve-vent can, and of its proper use, for packing and curing Cheddar cheese has enabled the cheese factory to provide the trade and the consumer with high quality Cheddar cheese in the consumer's package and without the development of rind that is wasteful to the consumer.

The vast investigations conducted under his directions concerning the keeping quality of powdered milk have been of great economic value to the dried milk industry.

His development of new marketable dairy products from concentrated and dried whey has enhanced the usefulness and market value of the by-products of the cheese factory.

In short, the contributions which Rogers has made to the dairy industry are legion. There is not a branch of our industry that has not felt the helping hand of his genius.

Mr. Wentworth, I have the honor to present to you Dr. L. A. Rogers, Chief of the Research Laboratories of the Bureau of Dairy Industry. By reason of his great achievements in the field of dairy science, and because of his outstanding contributions to the dairy industry, Dr. Rogers has been unanimously chosen by the American Dairy Science Association as its distinguished candidate for the honor of the Borden Award in Dairy Manufacturing."

Mr. Hunziker presented Mr. L. A. Rogers to Mr. Wentworth.

Mr. W. A. Wentworth representing the Borden Company was then introduced by President Graves and spoke as follows:

"Gentlemen of the American Dairy Science Association: At this moment in your convention proceedings we are to give recognition to two men who have been selected by their fellows as having achieved the most outstanding research work in dairying during the past five years. These men not unlike the remainder of you have been and are devoting their time, their energy, their experience, and their training—yes their culture—to progress in this great industry, dairying.

Nothing is more closely associated with the lives and fortunes of six million American farmers and one million of their like in Canada than is dairying. Progress from research brings to them wider markets, efficient hence profitable production, and economic processing and distribution.

Likewise, nothing is more closely associated with the lives and health of many millions of consumers in America and Canada than are dairy products. Progress from research has given and will give them products of this industry in which they will have confidence as to sanitation and wholesomeness. And progress in research will convince them of the nutritional qualities of milk and its products so essential to health of adults as well as children.

Research in the processing and manufacture of these products will surely reflect most advantageously to those who are engaged in milk production as well as to that great body of the public which is the market for milk and all of its products and by-products. In this field tremendous progress already has been made but the future field is limitless, unending.

Eighty years ago, Gail Borden founded what has now become The Borden Company. It was his genius for research which afforded him the product upon which he started to serve the public of New York City with a milk modified by concentration. He had seen the results from the use of milk in the condition then available and he set out to improve milk and thereby save lives and extend its availability. He wrote the first regulation for sanitary production of milk on the farm.

In recognition of the high value of research past, present and future and in perpetuating the ideals of its founder, The Borden Company sought some fitting manner in which research in dairying might be further stimulated and at the same time modestly rewarded. The American Dairy Science Association accepted the offer to administer two Borden Awards. One of these for most outstanding research work in dairy manufacturing and one for similar work in dairy production.

A committee from this Association has selected those two who in their estimation have accomplished this meritorious end.

On behalf of The Borden Company and its President, Mr. A. W. Milburn, I deem it a high privilege to present these gold medals accompanied by the payment of one thousand dollars to each of those who has been so honored by the American Dairy Science Association .

Dr. Lore A. Rogers of the Bureau of Dairying, U. S. D. A., Washington, D. C., for outstanding research work in dairy manufacturing; and

Professor Carl F. Huffman of the Michigan State College, East Lansing, Michigan, for outstanding research work in dairy production.''

Doctor Huffman replied as follows:

''Words cannot express my appreciation of the honor awarded to me. It is my opinion that many of my fellow workers in the field of dairy production have made greater contributions during the last few years to the progress of dairy husbandry.

My meager contributions have been largely due to the support accorded me by my associates at Michigan State College. The whole-hearted support given to our research program by O. E. Reed, former Head of the Dairy Department, Michigan State College, and now Chief of the Bureau of Dairy Industry, and E. L. Anthony, present Head of the Dairy Department and Dean of the Agricultural Division, accounts in no small degree for the accomplishments of our dairy production research. Our progress has also been due to the splendid cooperation and assistance of Dr. C. S. Robinson and C. W. Duncan of the Section of Experimental Chemistry, Dr. E. T. Hallman

of the Section of Animal Pathology and L. A. Moore of the Dairy Section. The work of several graduate assistants has also been of valuable assistance.

Our research program at Michigan State College during the past 15 years has been characterized by long time feeding experiments. The first experiment of this kind was designed to study mineral requirements and the effect of feeding different mineral supplements, since at that time the country was being flooded with complex mineral feeds, which were supposed to cure all the troubles affecting dairy cattle. The early work at various stations indicated that milking cattle were suffering from a calcium deficiency. In our work a basal ration consisting of high grade timothy hay, corn silage and a grain mixture low in calcium gave splendid results over a period of five years. Short time metabolism trials throughout lactation indicated that although the cows were on negative calcium balances during heavy production, they stored ample calcium during medium and low production and during the dry period. At the end of three lactations the animals were slaughtered. The bones were normal.

The groups of animals fed the basal ration supplemented with bone flour or finely ground limestone rock did no better from the standpoint of reproduction, milk production and bone development than the cows on low calcium ration.

Our results and those at Vermont showed that cattle on the farms do not suffer from a calcium deficiency even when low calcium roughages are used, providing the roughages are palatable and fed in large amounts.

A group of animals received a cheap mineral supplement consisting of equal parts of finely ground limestone rock and raw rock phosphate. The health of this group of animals was adversely affected. The teeth were badly worn and the long bones showed marked changes. It was later shown that the detrimental factor in this mineral supplement was the large percentage of fluorine in raw rock phosphate. Up to the time of this work, raw rock phosphate had been recommended as a cheap source of calcium and phosphorus.

The toxic effect of fluorine in raw rock phosphate and the phosphatic lime stones accounts for our recommendation of special odorless steamed bone meal as a phosphorus supplement for dairy cattle when such a supplement is needed.

You are all familiar with our results with a highly advertised complex mineral mixture, which when fed according to recommendations of the sponsors, injured the health of the animals to which it was fed, although it was supposed to do everything except milk the cows on the farm. These results demonstrated the fallacy of feeding high powered, high priced mineral concoctions. I have informed many dairymen that it would be better for them to take their families to a "movie" rather than buy highly advertised complex mineral mixtures. Their cows would be better off and their families

would have needed recreation. The use of such mixtures is a heavy tax on the dairy farmer.

We have in progress at the present time a long time experiment designed to study the symptoms of phosphorus deficiency and phosphorus requirements, when alfalfa and the cereal grains with and without corn silage make up the ration.

Many years ago the dairymen in certain sections of Michigan who fed alfalfa and the cereal grains reported that their cattle chewed bones and wood. This condition was relieved by feeding bone meal. With the increased alfalfa acreage, this problem became a very important one.

This experiment has been in progress nine years. We have observed that cattle suffering from severe phosphorus deficiency lose their appetite for roughage and do not manifest depraved appetite until they are on the borderline of phosphorus deficiency. The results have enabled us to formulate a tentative standard for milking cows, using appetite for hay, blood inorganic phosphorus values and short time balance trials as criteria of phosphorus needs. This work is the basis of our recommendation that cows fed a home grown ration of alfalfa hay and the cereal grains with and without silage be allowed free access to a mixture of equal parts of bone meal and salt.

In order to study the calcium and phosphorus relationship more effectively, the vitamin D requirement of calves and the vitamin D value of solar radiation, sun cured hay, corn silage, irradiated milk, cod liver oil and irradiated ergosterol have been studied.

Our results have shown the effect of vitamin D deficiency on the composition of the blood. The long bones of calves do not show changes in rickets as observed in animals which are helpless at birth. After years of study, we found that the distal end of the ribs of calves afforded the best opportunity for studying rachitic changes in calf bones. The macroscopic and microscopic changes in the distal end of the ribs are similar to the changes in the long bones of rats and children.

One of our most significant observations in connection with vitamin D and phosphorus deficiency studies has been the effect on the articulating cartilage. The pitting and erosion of the surface of the articulating cartilage brought about during a deficiency in early life, persists even though the animal receives ample vitamin D and phosphorus. These eroded areas are responsible for the name of "creep" given to phosphorus deficiency among cattle in some countries. The creeping sound is due to the rubbing of bone against bone in the articulating joint. The pits and eroded areas offer a fine place for microorganisms to lodge, which may produce arthritis. We believe the results of this work are not only of value to the dairy farmers in alfalfa areas but also have a human application.

We have also studied the effect of magnesium deficiency in the ration of calves. Such a ration results in a lowered blood plasma value. Long con-

tinued feeding of such a ration ends in the animal manifesting tetany, the production of hardening of the blood vessels, kidney injury, etc. We have worked out the magnesium requirement of calves using magnesium compounds and natural feeds rich in magnesium. The magnesium requirement of the calf and child per pound of body weight appears to be about the same. The results of this study do not have a practical application to farm conditions at the moment due to the high magnesium content of common dairy feeds.

For many years we have been studying the factors carried by hay. In connection with our first long time mineral feeding experiment a group of heifers were placed on the basal ration, except wheat straw was fed in place of timothy hay. The cows receiving timothy hay gave birth to good strong calves in every case, while the animals receiving straw had dead calves or calves which were weak and blind. The blindness was associated with constriction of the optic nerve. This work is now being carried on by L. A. Moore who has correlated this type of blindness with a lack of carotene in the ration of the dam.

It appeared from these studies that the blindness and reproductive failure observed in connection with cottonseed meal injury might be due to the lack of a factor or factors carried by good hay. A long time feeding experiment covering three generations showed that so-called cottonseed injury in cattle was prevented by feeding good hay and corn silage. As much as 17 pounds of cottonseed meal was fed per cow per day in the course of this work. Also, cottonseed meal was shown to be laxative rather than constipating in its effect on the feces.

During the past several years we have been studying the value of home grown rations of alfalfa and the various cereal grains with and without corn silage. This work has taught us how to feed these feeds to greater advantage and has aided in the formulation of new rules for feeding alfalfa hay, silage and grain. This new system enables the dairymen to market to better advantage through his cows and the crops grown on the farm. The present study of the value of roughages for milk production is yielding results which promise to be our greatest contribution to dairy production.''

Dr. Rogers responded with the following:

"Under the circumstances which exist here today, I think I may be pardoned if I am somewhat reminiscent. I am thus, not because I imagine that any recital of my past misdeeds will be of especial interest, but because I would like to impress on the younger men here the progress that has been made in the nearly forty years in which I have been engaged in investigations in dairy manufacturing. I want, also, to impress upon the younger workers that the earlier investigations that seem so simple and obvious in the light of our present knowledge, so easy with the equipment now available, were anything but simple and obvious the first time they were done. I am

often reminded of the late lamented Dr. Cook's statement in his account of his alleged ascent of Mt. McKinley in Alaska, to the effect that he made so much better time traveling over a route through the wilderness than a geological survey party had made the previous season. What he neglected to state was, that he was traveling on a path made by the Geological Survey party. Progress in a new field of science is always much easier and faster· if someone has made a path, but many investigators, like Dr. Cook, forget their indebtedness to the men who blazed the trail.

I would like also by citing some examples from my own experience to emphasize the value, even the necessity, of fundamental research in solving the practical problems which confront us.

I imagine that it is difficult for the younger people here to realize the changes which have taken place in the brief span of 40 years. When I began my work transportation was literally in the horse and buggy stage. Electric cars were comparatively new. Boys were still riding high-wheel bicycles, horseless carriages were not taken seriously, and the airplane was only a dream of crack-brained inventors. The telephone had not yet come into general use, and the radio was not even a dream. The scientific world had just been startled by the discovery and application to medicine of the Roentgen rays.

In the dairy field·pasteurization was discussed and used surreptitiously but was generally regarded with suspicion and hostility. Bacteriology was then a very young science, and the use of special cultures for buttermaking was a decided innovation, generally regarded as futile. Cream was ripened to a high acidity to develop a pronounced flavor, and protect it against deterioration.

It was into these conditions that I, an inexperienced, and according to our present standards, ill-trained young fellow only recently out of college, was projected to solve the problem of what made butter fishy. I suppose very few of you here have ever tasted really "fishy" butter, but in those days you couldn't avoid it. A large part of the butter held in storage became fishy. The butter maker at one of the large centralizer creameries which at that time made butter from unneutralized cream assured me that all of their butter put in storage would come out fishy.

This would be a comparatively simple problem in the light of our present knowledge and would be solved in the laboratory using tools and information which were unheard of at that time.

Instead of working in a laboratory, I went into the field to study the conditions in the creameries where fishy butter was made. How meager a conception I had of the nature of the problem may be gathered from the fact that much time and effort were spent in studying the flora of the pastures of the region. Two fortunate observations, made in the course of this work, led to more exact work and conclusions of some importance to the butter

industry. Storage butter which Mr. C. E. Gray and I had made at the University of Wisconsin creamery from sweet pasteurized cream was given a high score by commercial judges who knew nothing about the history of the butter, while ripened cream butters from the same lot went off flavor in proportion to the acid developed. The second observation was made at the hotel in the small Wisconsin town where I was working. After a summer of disappointment at the failure of the creamery to make any fishy butter I was elated to find on the table one night farm butter with a perfect fishy flavor. After some diplomatic negotiations through an intermediary who spoke the language of the natives I was able to examine the cream from this farm and the butter made from it. This disclosed nothing unusual, except the presence of an exceptionally active lactic culture, but with this culture I was able to make, experimentally, butter which became fishy.

I cannot say that I ever found the cause of fishy flavor. Some of the statements we made are, in the light of more recent work, obviously incorrect. But it is safe to say that the work which developed from these field observations established the fact that much of the deterioration of butter, and especially butter held in cold storage, is due, not to bacteria, but to chemical changes in which oxidation accelerated by acid and metal salts, play the important rôle. While these results were received with skepticism, in a few years, as pasteurization came into general use, the high acidity formerly developed in the cream before churning was gradually replaced by a very mild ripening or by no ripening at all. The result of this change has been an almost complete disappearance of fishiness and some of its related flavors. The greatest value of this work at the present time, and the only excuse for introducing it here, is the example which it affords of how not to do research work.

If this investigation could have been properly conducted in a laboratory by a personnel qualified to measure and evaluate delicate chemical changes and the factors which control them, conclusive results could have been obtained in half the time. But this merely proves that hindsight is better than foresight.

My official classification is Bacteriologist, and I have ventured into that field even to the extent of doing some work which could be classed as pure bacteriology, a term which I dislike very much because it carries the implication that bacteriology which has an application is impure or corrupt.

At one time we became interested in the gas-forming bacteria occurring in milk which led us at once into the confusion of the colon aerogenes group. At that time, while there had been two or three papers indicating the lines of demarcation between the families of the group, there were no certain means of distinguishing one species from another, and their sanitary significance was a matter for debate. By applying exact chemical methods we were able to distinguish two physiologically distinct species, one of intes-

tinal origin, and one widely distributed in nature and, consequently, of no sanitary significance in water, and established simple tests for differentiating one from the other.

While these results had a value in bacteriological work, the really significant outcome of this investigation was Dr. Clark's classical research on the determination of the hydrogen ion and its application in biology. Physical chemists were discussing the hydrogen ion but to bacteriologists it was news from a new battle front. It is hardly possible to overstate the importance of this work in all branches of biological research, and in the industries its applications appear in the most unexpected places. To me, its greatest use is the example which it provides of the value of abstract research in solving industrial problems.

When Dr. Clark first showed us that the growth of microorganisms was controlled by the hydrogen ion concentration to which the titratable acidity was an unsafe guide, Dr. James M. Currie was working on the acids produced by various molds isolated from Roquefort cheese, a subject which in itself did not promise any results of immediate value. Among these molds he had one which produced an unusual amount of citric acid. Dr. Currie reasoned that by controlling the hydrogen ion concentration of a culture medium at the proper point, he could maintain his molds free from bacteria and produce citric acid commercially. There was a long and rough road between the idea and its successful commercial development, but the factory that finally materialized makes citric acid in quantities measured in tons per day.

At the time this country went into the World War there was a demand for large quantities of casein of high purity for use in airplane construction, and we were asked how it could be obtained. After a night of consideration, Dr. Clark outlined a method of making casein which involved precipitation and washing of the casein at its isoelectric point. This he predicted would maintain the casein in a granular condition, which would facilitate the removal of the impurities which affected the adhesive strength of the product. These principles have proven so sound that through their application a large commercial factory now makes a casein approximating in its purity and strength the standard Hammerstein casein of the laboratory.

Another example of the unexpected application of abstract research to industry is found in an attempt we made to explain why a bacterial fermentation always ran a definite course and stopped when certain conditions were established. We found that by maintaining the pH at the optimum reaction for a particular culture a rapid and complete fermentation of the lactose whey could be induced and, further, that by supplying fresh fermentable material the fermentation could be maintained almost indefinitely at a maximum speed. As a result of this work lactic acid is now produced profitably on an extensive scale from whey. While the continuous method is not used

the capacity of the fermentation plant may be doubled at any time by introducing this procedure.

An indefinite number of illustrations could be given of the unexpected results of practical value which have come from investigations which were planned to solve some problem of a purely abstract nature. It may be possible to predict the answer to the question first asked, but no one can foresee the sidelines which may develop.

·There is a border line between what we are in the habit of calling invention and investigation that is difficult to define with exactness. We usually think of invention as something that develops more or less spontaneously in the mind of a brilliant person while new ideas that come through investigation are the result of time and labor. Edison may be taken as the type of the inventor, while Langmuir, with some brilliant inventions to his credit, is clearly an investigator.

In the dairy industry a large part of the progress has been due to the inventor type. In our own work the method of canning cheese could properly be classed as invention, and like many other projects of this type, now serves as an illustration of how not to be an inventor. The large commercial laboratories are now attacking problems of this type by systematic, logical methods which rarely fail to produce results.

The first step is a clear definition of the problem. In this case it was to develop a package which would obviate the evident disadvantages of the usual methods of selling cheese. If, among the several methods available, the tin can was selected as the most likely solution, the problem of disposing of the gases formed in the normal ripening would soon be evident to anyone experienced in cheese work. While there were several possibilities, the element of invention would come into the investigation at this stage in the conception of a valve which would permit the escape of the gas without admitting air. While this seems a perfectly obvious thing to do after it is suggested the one who makes it obvious is an inventor.

In the art of invention as it is practiced in the good commercial laboratories the valves already on the market would be studied and if any seemed promising, methods and apparatus devised for testing them under controlled conditions.

The requirements which must be met are ability to exclude air under all conditions, invariable release at a predetermined low pressure, freedom from sticking, and a low cost. All of these things can be measured by physical instruments and designs and materials selected before the crucial test of packing cheese is made. How far we were from following approved methods may be inferred from the fact that we tested the valves by canning cheese, and when one was finally perfected and a patent obtained we found that at least two earlier patents had been granted on almost identical valves.

There is one point on which I think I may be pardoned for feeling some pride and satisfaction. This is the quality of the men and women who have been associated with me in various capacities in the work of the Dairy Industry laboratories. I need mention only a few of the former members of our staff: Mr. C. E. Gray; Dr. Meigs; Dr. S. Henry Ayers; Dr. Alice C. Evans of the National Institute of Health; Dr. Clark, Professor of Physiological Chemistry at Johns Hopkins University; Dr. Anne Benton, formerly Professor of Bacteriology at Vassar; Dr. Sherman of Cornell; Dr. Parfit· of Purdue; Drs. Jackson and Frazier of Wisconsin; and Dr. Mudge of California.

Although we have never had more than five or six bacteriologists in our organization, four Presidents of the Society of American Bacteriologists, a society of one thousand members, have made their reputations in our laboratories. Two former members of our staff are members of the National Academy of Sciences. In securing men of this type we have been favored by fortune, but I would like to think that good judgment and discretion were factors of some importance.

It is not easy to obtain good men in the government service. The laws and the regulations governing appointments to the classified civil service are based on negative concepts. The viewpoint is not how can the best man for a particular position be obtained, but how can every citizen of the United States be given an equal opportunity to secure this position without influence or favoritism. But even in this the law is not consistent and one group of citizens is so favored that we frequently find our selection limited to men who are at the head of the list, not because they are better educated or more experienced than their competitors, but because they have acquired a disability in the military service.

Under these restrictions the wisest course is to select the most promising young men and develop them, so far as their natural capacity will permit, into investigators. Training investigators is like bringing up children and by the same token those who have had the least experience are the most positive about the methods that should be used. Real investigators, like baseball players, are born not made, but no one can tell what talent may be latent in unpromising material until it has an opportunity to develop. In a research organization everyone should be given as much independence and responsibility as he has demonstrated he is capable of assuming. This is said with a full realization that some men work best in· double harness and to permit them to wander about without guidance or supervision is an unkindness.

In these days of efficiency engineers, advisory boards, and high-powered executives, it is hard to prevent a research organization from being stifled by over-organization, especially when it is a small unit in a gigantic institution like the Department of Agriculture.

Jefferson's political views may be out-moded, but his opinion that the best government is the one that governs least still applies to the organization of a research laboratory. The organization should be so flexible that it can be fitted to the men available. Nothing is so deadening to a research spirit as an attempt to force a group into a rigid form of organization for which they are not fitted by temperament or experience. On the other hand, it must be recognized that many of our present day problems can only be solved by a group working in cooperation. No doubt material economies of money, effort and time can be effected by properly organized investigation, but those who attempt to follow this path should first consider that successful cooperative research involves a carefully selected personnel, and on the part of some responsible person, infinite patience, perspicasity and eternal vigilance.

R. B. STOLTZ, *Secretary*

THE THIRTY–SECOND ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLTZ

Secretary-Treasurer

The American Dairy Science Association was called to order by the President, R. R. Graves, in the College Activities Building on the campus of the University of Nebraska on Wednesday morning, June 23, at 9:30 A.M., for the thirty-second annual meeting. The program printed in the June issue of the JOURNAL OF DAIRY SCIENCE was arranged by a program committee headed by H. P. Davis. The July issue of the JOURNAL contains the abstracts of the various papers presented.

According to Prof. I. L. Hathaway, who had charge of registration, the attendance showed that thirty-nine states and the District of Columbia, as well as Canada, Australia, New Zealand, Denmark, British South Africa and China were represented; 228 of the 303 registrants were members. There were 76 ladies and 32 children, making a total attendance of 411. This meeting set a record for having the widest distribution of states and countries represented.

Chancellor E. A. Burnett gave the address of welcome. President Graves responded and gave a brief review of the changes that have taken place in the production side of the industry during the past seventy-five years in the United States, with some observations as to the possible trend of the changes and the part that our research may be called upon to play in the shaping of future changes.

Prof. W. H. Morton, of the University of Nebraska, was then introduced and gave a very interesting and instructive talk, entitled "How a Teacher Interprets Research."

Mr. H. Wenzel Eskedal, Landokonomisk Forsogslaboratorium, Copenhagen, Denmark, presented a paper on "Breeding and Feeding Dairy Cattle in Denmark."

Mr. O. F. Hunziker, chairman of the Journal Management Committee, presented his report which is reported in the minutes of the Board of Directors.

GENERAL BUSINESS SESSION

Friday, June 25, 10:00 A.M.–12:00 NOON

College Activities Building, Univ. of Nebraska

SECRETARY-TREASURER'S REPORT

Circulation: A list of members and subscribers was published in the December Journal last year—members 853 and subscribers 888, making a total of 1741. This year we have

H. W. GREGORY, PRESIDENT

had 70 members lapse and 267 subscribers lapse, making a total decrease circulation of 337. We have taken in enough new members and new subscribers so that the total circulation on June 23, 1937, was 1692. We trust that before the year 1937 ends our circulation will be not less than 2,000.

The secretary-treasurer has been authorized to have an insert printed which may be used by educators to insert letters of inquiry referring the inquirer to the JOURNAL OF DAIRY SCIENCE.

The financial report of the secretary-treasurer and the report of the public accountant was then read.

Mr. J. H. Erb, chairman of the Auditing Committee, presented the following report:

<div align="right">June 18, 1937</div>

To the Members of the
American Dairy Science Assn.

Gentlemen:

The auditing committee of the American Dairy Science Association has made an examination of the books and statements of the Secretary-Treasurer as of December 31, 1936.

It is our opinion, based upon such examination, that the books have been kept accurately and that the balance sheet and related summary of profit and loss fairly present the financial condition of the American Dairy Science Association.

<div align="right">Respectfully submitted,
H. E. OTTING
T. S. SUTTON
J. HOFFMAN ERB, <i>Chairman</i></div>

The proceedings of the Board of Directors was then presented by the Secretary.

<div align="center">MEETING OF THE BOARD OF DIRECTORS</div>

<div align="center"><i>June 22, 1937, 3:00 P.M.</i></div>

The meeting was called to order by the President.

Present: R. R. Graves, H. W. Gregory, C. R. Gearhart, J. A. Nelson, Earl Weaver, E. G. Hood, R. B. Stoltz and H. P. Davis.

Absent: H. A. Ruehe and M. Mortensen.

An invitation was presented to the Directors inviting the Association to hold its next annual meeting in Ohio at Columbus and Wooster on June 14 to 17, 1938. Upon motion by Mr. Gearhart, seconded by Mr. Nelson, the invitation was accepted.

It was moved by Mr. Weaver, seconded by Mr. Nelson, that in the future the policy of our Association will be to accept applications for membership only from residents of North America.

O. F. Hunziker, Chairman of the Journal Management Board, submitted a report telling of the 1936 performance of the Journal and including the following recommendations:

1. That the Journal publish the abstracts of literature on dairy cattle.
2. That the January Journal not be sent out until after membership dues or subscriptions have been paid.
3. That the Association purchase all back numbers of Journals from the Williams and Wilkins Company.
4. That the stock of all Journals be insured.

Mr. Gregory moved, Mr. Nelson seconded, that the report and comments of the Journal Management Committee, as a whole, be adopted in its amended form. The above report is in the corrected form.

Upon motion duly seconded the Board of Directors then adjourned.

MEETING OF THE BOARD OF DIRECTORS

June 23, 1937, 4: 00 P.M.

Dairy Building, Lincoln, Nebraska

Present: R. R. Graves, H. W. Gregory, J. A. Nelson, Earl Weaver, Martin Mortensen, E. G. Hood, R. B. Stoltz, H. P. Davis and C. R. Gearhart.

Absent: H. A. Ruehe.

Mr. Joe Knott came before the Directors at the previous Board meeting and invited the Association to hold its 1939 meeting on the campus of Washington State College and the University of Idaho, these two institutions to act as the joint hosts for the meeting. At this meeting of the Board the invitation was discussed and upon motion duly seconded was accepted.

After a discussion of the rules governing the Borden Award, it was agreed that the rules as changed in accordance with the suggestions agreed upon should be drawn up and submitted to the Directors for further suggestion and for approval.

Mr. Weaver moved and Mr. Gearhart seconded that the President appoint a committee to devise and recommend a procedure that is to be followed by various committees and sections that have passed resolutions, motions or statements on which it is desired to have the endorsement or approval of the American Dairy Science Association. President Graves appointed Mr. Weaver, Mr. Nelson and Mr. Gearhart to serve on this committee.

Mr. Weaver moved, Mr. Mortensen seconded, that the Board of Directors express our thanks to the Ohio members for their invitation to meet in Ohio in 1938.

The following resolutions submitted by the program committee were unanimously adopted by the individual members of the Board of Directors who were present:

RESOLUTIONS SUBMITTED BY THE PROGRAM COMMITTEE TO THE BOARD OF DIRECTORS

1. It is suggested that the composition of the Program Committee in the future shall be as follows: the chairman of the committee, as at present, is to be appointed by the

president of the Association at the institution which entertains the Association. The committee shall consist of three additional active members, namely, the chairmen of the Production, Manufacturing, and Extension sections. The committee shall have two additional advisory members, namely, the past two committee chairmen.

2. It is recommended that in the future no papers are to be considered by the Program Committee unless the abstracts of the papers are submitted with the title.

3. It is recommended that titles and abstracts of papers must be in the hands of the chairman of the Program Committee by April 15.

4. It is recommended that abstracts be limited to five hundred words and that charts, graphs, photographs and tables not be accepted.

5. It is recommended that members of the Association are to be limited to two papers of which they are authors or co-authors unless in the judgment of the committee additional titles and abstracts which are submitted fit into the program being planned.

6. It is recommended that abstracts of papers accepted by the Program Committee be not put on the program but read by title and the abstract published.

7. It is recommended that the Board of Directors consider recommending to the Journal Management Committee the possibility of publishing both the program and the abstracts as the June issue of the JOURNAL OF DAIRY SCIENCE.

Respectfully submitted,

H. P. DAVIS, *Chairman*
S. I. BECHDEL
L. S. PALMER

Mr. F. W. Atkeson submitted the report of the Production Section:

The Production Section met in Room 303 of the Dairy Building at the times scheduled on the program. F. W. Atkeson, Chairman of the section, presided at the sessions. All sessions were well attended and the quality of, and interest in, the papers presented continued at a very high level throughout. All but one of the papers listed were presented.

At the business meeting of the Production Section the Breeds Relation Committee brought in an interim report as well as a current report. The interim report, dealing with certain recommendations relative to general uniformity in matters of number of cows to be included and supervised on herd test, was adopted as presented. The current report covered two matters:

1. The proposal to amend the interim report to permit the supervision of a maximum of sixty milkings daily where individual samples are taken was adopted by the section.

2. The proposal to change the method of computing herd averages for the herd test was discussed and referred back to the committee for further consideration.

The committee on the students' judging contest reported one change in the rules for the conduct of the 1937 contest, regarding grading of oral reasons which will be done by one special judge for each breed.

A progress report of the Committee on Methods of Measuring Results of Pasture Investigations was made by R. B. Becker (Florida) and was adopted by the Section.

A progress report was presented by the special committee appointed to investigate cooperation with the committee of the Manufacturing Section on Standard Methods. The report was accepted and it was voted to make this a standing committee of the section.

Officers elected for the year 1938 were: W. E. Krauss, Chairman; H. W. Cave, Vice-chairman; I. R. Jones, Secretary.

This report is respectfully submitted by

F. W. ATKESON, *Chariman*
I. W. RUPEL, *Secretary*

Mr. P. H. Tracy read the report of the Manufacturing Section:

The Manufacturing Section has met in accordance with the schedule indicated in the official program. All but five of the fifty-one scheduled papers were presented. Papers m15, m16, m21, m35, m38 were not given due to the absence of the authors or their representatives. The sessions were all well attended and were operated strictly on scheduled time.

The revised score card for sanitary inspection of dairy farms and for the sanitary inspection of city milk plants was presented by the Score Card Committee and accepted by the Section. Reports were heard from the following committees:

1. Chemical Methods for the Analysis of Milk and Dairy Products.
2. Dairy Products Quality.
3. Bacteriological Methods for the Analysis of Milk and Dairy Products.
4. Judging Dairy Products.
5. Methods of Determining the Curd Tenison of Milk.
6. Feasibility of Establishing and Maintaining a Loose-Leaf Manual of Laboratory Methods.

C. J. Babcock of the Bureau of Dairy Industry was elected Chairman of the Section for the forthcoming year, and B. E. Horrall was elected Secretary.

P. H. TRACY, *Chairman*

Mr. C. L. Blackman read the report of the Extension Section:

The annual program of the Extension Section of the American Dairy Science Association was held in Room 102, Animal Husbandry Hall, Wednesday, Thursday and Friday, June 23, 24 and 25, 1937, with Professor C. L. Blackman, of Ohio State University, Chairman of the Section, presiding. A total of thirty papers were presented with an average attendance of sixty-five.

The program was arranged and carried out under the direction of a program committee. M. L. Flack, of Nebraska, was chairman assisted by E. J. Perry, of New Jersey, and Earl Shultz, of Iowa State College.

Assisting the general program committee were committees on extension exhibits, breeding, feeding, testing, calf club, quality and resolutions. The chairman of each committee presided for the presentation of papers by other members of the committee. The personnel of the committees, the subjects and schedules carried out are shown in the official program of the association.

The regular business session was held Friday morning, June 25, from 8 to 10 A.M. The following resolutions were adopted:

1. Whereas the Extension Section program committee, M. L. Flack, Nebraska, Earl N. Shultz, Iowa, and E. J. Perry, New Jersey, spent much time and energy outlining and planning this year's program and that as a result of their efforts all except one abstract was received, we therefore commend this committee and wish to thank those who appeared on the program.
2. The section wishes to thank the members of the faculty of the Dairy Department of the University of Nebraska for the facilities placed at our disposal and the many courtesies extended to us, both of which have contributed to making our meeting here successful and enjoyable, and that a copy of this resolution be given to Professor H. P. Davis, by the secretary of the section.
3. WHEREAS, there has been considerable discussion at this meeting regarding uniform rules and regulations for conducting D.H.I.A. testing, and Whereas, the summary of a questionnaire regarding rules sent to all the states indicated the almost unani-

mous feeling on the part of the men in these states who are actually engaged in the supervision of D.H.I.A.'s, that we should move cautiously,

Therefore, *Be it resolved* that only such regulations be adopted that are necessary to insure accuracy and establish confidence and yet be workable and not discourage testing.

4. WHEREAS, with the widespread recognition and general acceptance of the national identification and permanent record program, and whereas, there seems to be some apprehension of some national dairy breed associations as to the purposes of this program,

Therefore, *Be it resolved* that this section here assembled go on record as (1) heartily endorsing the program and urge the continued cooperation of the states, (2) that the program and the persons connected with it proceed in such a manner that there will be no conflict with or intentions to replace the breed herd tests, (3) that the program is not set up to establish a grade cow registry, but rather as a system of practical identification heretofore not in existence, and that a copy of this resolution be given to the breeds relation committee.

A new secretary is elected each year. The former secretary automatically becomes vice-president and the vice-president automatically becomes president. R. G. Connelly, of Virginia, was elected secretary, S. J. Brownell succeeded to the office of vice-president and Earl Shultz, of Iowa, became president for the coming year.

The section adjourned following a paper by J. Rockefeller Prentice, President of the American Dairy Cattle Club.

Mr. C. Y. Cannon, chairman; P. S. Lucas, J. C. Knott, J. W. Lynn, and E. S. Guthrie reported for the Nominating Committee as follows:

> *For Vice-President:*   C. E. Wylie—Tennessee
>   Earl Weaver—Michigan
> *Director:*   R. B. Becker—Florida
>   E. V. Ellington—Washington
> *Director:*   George C. Supplee—Dry Milk Co., Bainbridge, N. Y.
>   Harold Macy—Minnesota

Mr. C. J. Babcock, chairman of the Score Card Committee, consisting of L. H. Burgwald, A. D. Burke, H. F. Judkins, C. L. Roadhouse, and H. E. Ross, reported as follows:

REPORT OF COMMITTEE ON SCORE CARDS FOR THE SANITARY INSPECTION OF DAIRY FARMS AND MILK PLANTS

Because of popular demand the score cards for the sanitary inspection of dairy farms and the sanitary inspection of city milk plants have been revised, and are herewith submitted to this Association for approval.

The Committee admits that it found it impossible to incorporate in these score cards all the suggestions which they received, also that the values given to some of its items were reached by compromise. They represent, however, the earnest efforts of the committee for the past two years and the committee believes that the score cards as here presented are up-to-date, complete and practical.. They were unanimously approved by the Dairy Manufacturing Section of this Association, June 24, 1937.

I, as Chairman of the Score Card Committee, therefore, respectfully request the approval of these score cards by this Association.

<div style="text-align:right">C. J. BABCOCK, Chairman</div>

Dr. P. F. Sharp, of Cornell, chairman of the Committee on Milk Standards, reported that they would like to submit their report to the members and ask for its approval at the next annual meeting.

The Resolutions Committee gave the following report:

REPORT OF THE RESOLUTIONS COMMITTEE

Whereas the American Dairy Science Association assembled at their 32nd Annual Meeting at the University of Nebraska has enjoyed a most satisfactory program and many courtesies extended by the faculty members of the University of Nebraska and their wives. Therefore, *Be it resolved:*

That the membership of the American Dairy Science Association and their wives take this opportunity of expressing sincere appreciation to the staff of the University of Nebraska and other organizations responsible for our entertainment.

WHEREAS the Borden Company has expressed interest in dairy research to the extent of providing two $1000 awards for outstanding research in two fields of dairying and whereas the Borden Company has shown confidence in the American Dairy Science Association to the extent of asking the Association to administer these awards. Therefore, *Be it resolved:*

That we express our thanks to the Borden Company for these generous awards and for their interest in this Association. *Be it further resolved* that a copy of this resolution be sent to the Borden Company.

WHEREAS, the Bill S-2359, entitled "A Bill to Provide for the Establishment of a Bureau of Coordination of Milk and Milk Products Regulation in the Department of Agriculture, and for Other Purposes," introduced into the Congress of the United States by Senator Copeland, of New York, proposes among other things to abolish the Bureau of Dairy Industry as a major bureau in the Department of Agriculture, and to merge the activities of the said Bureau of Dairy Industry with those of the regulatory agency created by the said Bill; and

WHEREAS, the merging of regulatory and research activities into one organization results in the subordination of research work to regulatory activities; and

WHEREAS, it is the sense of this meeting that the abolition of the Bureau of Dairy Industry as an independent research bureau will be prejudicial to the best interests of the dairy industry in the United States;

Therefore, *Be it resolved* that the American Dairy Science Association voice its disapproval of the so-called Copeland Bill and urge that it be not enacted into law; and

Be it further resolved, that a copy of this Resolution be sent to the Committee on Agriculture and Forestry of the United States Congress.

<div style="text-align:right">

K. S. MORROW
R. B. BECKER
J. H. FRANDSEN
H. C. JACKSON
J. B. FITCH, *Chairman*

</div>

Upon motion duly seconded, each report submitted was adopted and the actions of the Board of Directors for the past year were approved.

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ERRATUM

In table 1 on page 687 no bacteria were seen in the 60 fields examined for milks Nos. 2, 3, 4, 6, 8, 9, 10, 11, and 13. The count for each of these samples was actually zero but was to have been given as being less than 10,000. Table 1 gives the erroneous figures of 10,000 for each of these counts.

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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JOURNALS

American Creamery and Poultry Produce Review
American Journal of Diseases of Children
American Journal of Public Health
Archives of Pediatrics

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Certified Milk

Dairy Produce Review
Dairy World
Deutsche Molkerei Zeitung

Food Industries
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Ice and Refrigeration
Ice Cream Field
Ice Cream Industry
Ice Cream Review
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Journal of Bacteriology
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Journal of Physical Chemistry

Kaeseindustrie
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Lancet
Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry

Milk Plant Monthly
Molkerei Zeitung

National Butter and Cheese Journal

Pacific Dairy Review

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
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National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

1. The Vitamin Requirements of the Lactic Acid Bacteria. S. ORLA-JENSEN, N. C. OTTE AND A. SNOG-KJAER, Tech. College, Kopenhagen, Zentr. Bact. II, *94*, p. 434, 1936.

True lactic bacteria do not grow in milk deprived of the vitamins of the B-group. Besides the lactoflavin they need another thermostable substance which is alkali fast and influences also favorably the growth of yeast. This activator must be considered identical with pantothenic acid, the main constituent of bios. This means that vitamin B_2 must consist of bios and lactoflavin. The rod shaped lactic acid bacteria need more of both activators than the streptococci, especially more lactoflavin (0.5 mg per liter), they need also a third activator which is not adsorbed by charcoal and may be obtained after evaporation of whey with the first fraction of the lactose crystals. It is possible to determine the bios and lactoflavin content of various materials by adding them to carbon treated milk and titrating the acid after this milk has been incubated with a suitable lactic acid bacterium. K.J.D.

2. The Vitamin Requirements of Various Bacteria Except the Lactic Acid Bacteria in Milk. S. ORLA-JENSEN, N. C. OTTE AND A. SNOG-KJAER, Tech. College, Kopenhagen. Zentr. Bact. II, *94*, p. 447, 1936.

The propionic acid bacteria and the tetracocci need bios and lactoflavin; the latter do not form pigment in carbon treated milk (except *Sarcina flava*). The pseudolactic bacteria, the coli-aerogenes group, do not depend upon these activators to grow in pure synthetic media. The same is true with *Microbacterium lacticum*, whereas the hay- and potato-bacteria thrive even better without these activators. The fluorescent bacteria and *Bacterium pyocyaneum* on the contrary grow better in untreated milk. They also produce more pigment then, whereas *Bacterium prodigiosum* behaves the opposite way. It looks as if the bios is the substance which prevents this bacterium from producing pigment in milk. This would mean that prodigiosin acts like bios. If the bacterium is given enough bios in the medium, it does not need to build it by itself. Similar experience has been made with *Bacterium violaceum*. Chemically the fluorescein has been proven to be a flavine. K.J.D.

3. On Growth Factors Present in Peptones. S. ORLA-JENSEN, N. C. OTTE AND A. SNOG-KJAER, Tech. College, Kopenhagen. Zentr. Bact. II, *94*, p. 452, 1936.

Most commercial peptones used for bacteriological purposes have enough lactoflavin but their bios content, however, is only sufficient for the streptococci. The commercial proteolytic enzymes contain plenty of lactoflavin and bios and possess moreover some other activators which promote especially the growth of the intestinal lactic acid bacteria.   K.J.D.

4. The Nitrogen Requirements of the Lactic Acid Bacteria. S. ORLA-JENSEN, N. C. OTTE AND SNOG–KJAER, Tech. College, Kopenhagen. Zentr. Bact. II, *94*, p. 460, 1936.

The true lactic acid bacteria are especially particular in their nitrogen requirements. The problem was to prove whether the lactic acid bacteria could feed on simple nitrogen sources if the necessary activators were given.

The authors reached the following conclusions: Whey made free from protein by acidifying contains all activators necessary for the development of lactic bacteria. On the other hand it is a very poor nitrogen source which makes it very suitable for investigations of nitrogen compounds necessary for lactic acid bacteria. Naturally the data need confirmation by additional experiments with synthetic media. Colloidal caseinates are as good a source of nitrogen as the peptones, although lactic acid bacteria occurring in milk do not excrete caseolytic enzymes. They grow, therefore, much better in milk than in whey for lactalbumen seems to have no importance at all for the nutrition of the lactic acid bacteria. The thermobacteria as well as the other lactic acid bacteria do not require tryptophane but they need more or less cysteine, tyrosine (or phenylalanine), lysine, histidine, arginine, glutamic acid, asparagine, and creatine. Glutathion may be harmful in some cases. The *streptobacteria* can utilize ammonium salts and traces of *cysteine*. Creatine, diketopiperazine and probably also glutamic acid may be useful. *Streptobacterium plantarum* likes histidine and lysine, *Streptobacterium casei*, however, does not. The streptococci can live on ammonium salts as the only nitrogen source, but prefer the presence of histidine and leucine. These experiments with synthetic amino acid media confirmed the results of the first part of these papers concerning the need of lactoflavin and bios for the development of lactic acid bacteria. It could be further shown that the rod forms probably require a third activator which can be obtained with the first fraction of the lactose crystals, if the whey is evaporated.

                               .   K.J.D.

5. The Metabolism of Single Cells of Different Strains of Streptococcus Lactis. J. SUPINSKA AND T. MATUSZEWSKI, Inst. of Microbiology and Agr. Industry, Warsovie. Zentr. Bact. II, *94*, p. 499, 1936.

It was shown that the cells of *Streptococcus lactis* ceased to be in the logarithmic phase of growth and are already in the so called initial stationary phase when growing in milk at 0.3 to 0.8 per cent lactic acid. Statistical analysis of the possible relationships between the volumes of the cells and

their vital functions showed that, on the average, the larger the cells the greater the acid production and that the rate of reproduction also proved to be directly proportional to these two vital functions. The calculation of the partial correlation coefficient, under elimination of the fermenting ability, revealed a distinct negative correlation between the volume of the cells and the rate of reproduction. K.J.D.

6. **Differentiation of Lactic Acid Bacteria in Starters.** W. C. Smit, Tech. Hochsch. Delft, Holland. Zentr. Bact. II, *94*, p. 289, 1936.

For those doing control work in creameries it is of great interest to know if the starter contains enough aroma bacteria. It is impossible, however, to differentiate the lactic acid streptococci from the betacocci by means of the microscope or of any one of the common culture media. The author studied a series of special media and found that the milk powder agar of Ayers and Mudge (Formula A) was indeed suitable to distinguish *Streptococcus lactis* colonies from the betacocci colonies. The colonies of the former are surrounded by a turbid halo whereas the latter ones do not change the medium. The results are better, if instead of commercial peptone Orla-Jensen's casein peptone is used and if the agar concentration is lessened. The pII should not be allowed to exceed 7.0 before sterilization and the milk powder agar should always be used in a freshly prepared state (not older than 3–4 weeks). The plates should be incubated a few days at 25° C. K.J.D.

7. **Contribution to the Knowledge of Alkali Formers in Milk.** W. Storck, Milchw. Forschungsanstalt in Kiel. Zentr. Bact. II, *94*, p. 295, 1936.

The prevalence of the nonacid formers in milk during the colder months permits the alkali formers to play an important rôle. Their identification and isolation is easy since there is no need of using enrichment media. Their colonies are readily recognized on chinablue-lactose agar by a distinct colorless halo in the blue-grey agar. The isolated alkali formers belonged to the following groups (in diminishing frequency): Micrococci, Corynebacteria, Mycobacteria, spore formers, streptococci, Alcaligenes, Fluorescens, Proteus and sarcina.

Their growth in milk and dairy products is generally detrimental to quality. These may cause sweet curdling slime production and off flavors in milk. Their fat splitting properties produces deterioration of butter. On the other hand many of them may be of some value for soft cheese making, since they are able to attack the casein. This ability is promoted by their salt tolerance and growth at cheese ripening temperatures. They do not survive pasteurizing temperatures. K.J.D.

8. Incidence and Significance of Beta Hemolytic Streptococci in Cultures From a Selected Group of Milk Handlers. FRANKLIN M. FOOTE, Yale Univ. School of Med., New Haven, Conn., and HENRY WELCH, D. EVELYN WEST AND EARLE K. BORMAN, Conn. State Dept. Health, Hartford, Conn. Am. J. of Pub. Health *26*, 799, August 1936.

The authors studied 756 throat and 756 nose cultures obtained weekly over a week period from 85 milk handlers employed at 5 dairies including distributors of raw and of pasteurized milk. Transportation of throat and nose swabbings through the mails resulted in a reduction of approximately 50 per cent in positive findings. Twenty of the 85 milk handlers harbored beta hemolytic streptococci at least once. Five of the 20 individuals were persistent carriers.

Results indicated that strains of beta hemolytic streptococci found in individuals in an average state of health are indistinguishable from strains of known pathogenicity for man and are potential human pathogens assuming the lytic action of any strain on human fibrin to be associated with its invasive power.

With regard to the problem of milk-borne streptococcus infections the results indicated that:

(a) Physical examinations alone are not sufficient for the detection of all carriers of beta hemolytic streptococci.

(b) Routine laboratory cultures are inadequate for the detection of all carriers, unless made more frequently than is practicable under ordinary administrative conditions.

(c) Beta hemolytic streptococci do not withstand drying and other factors associated with delay in transportation to the laboratory sufficiently well for the detection of carriers in a central laboratory with any adequate degree of completeness.

(d) Two types of carriers of these organisms, transient (or occasional) and persistent occur among milk handlers in an average state of health, and the organisms of this type are potentially pathogenic for man, should sufficient numbers find access to the milk.

(e) The percentage of persons harboring these organisms is too large to permit adequate control of milk-borne streptococcus infections by employing any practical measures to eliminate the carriers.

(f) Since the frequency of the carrier state seems to bear no close relationship to the frequency of milk-borne streptococcus infections, outbreaks probably occur only when a comparatively large inoculum of infecting organisms reaches the milk from an udder infected by a milker or, probably less often, from some other source.

(g) Consumers must be protected against milk-borne streptococcus infections by other means than by periodic physical and laboratory examinations.   M.W.Y.

9. **Practical Methods of Testing For Mastitis.** J. M. ROSELL, Ministry of Agriculture of Quebec, Canada. Am. J. of Pub. Health *26*, p. 872, Sept., 1936.

Methods generally used for detecting mastitis are summarized. For rapid and efficient work, the author recommends that in testing a herd for mastitis, the order of tests to be used with quarter samples should be as follows: (a) pH with brom thymol blue; (b) rapid catalase with 9 per cent hydrogen peroxide; (c) rapid chloride test, and after or before this test, (d) the black sieve cloth test, and (e) palpation and clinical examination of the udder. M.W.Y.

10. **An Outbreak of Epidemic Sore-Throat of Milk-Borne Origin.** F. E. CAMPS AND J. L. MILLER. Lancet *231*, p. 756, Sept. 26, 1936.

An infected raw milk supply caused 1600 cases of sore-throat, mostly in adults, in and around Chelmsford in August, 1935. Many of these were reported as scarlet fever, although rashes occurred in only a limited number of cases. The source of the epidemic, in which 6 deaths occurred, was a farm where four cow men were found to have been infected with *Streptococcus pyogenes* (Type 2). This milk supply was shut off until it was pasteurized. The outbreak was a typical milk-borne one, with sudden outburst of disease quickly reaching a peak, and there were relatively few secondary cases. The schools were not closed. J.A.T.

11. **Enteric Fever in Milk-Borne and Water-Borne Epidemics. A Comparison of Age- and Sex-Incidence.** A. BRADFORD HILL AND K. MITRA. Lancet *231*, p. 589, Sept. 5, 1936.

In order to determine the truth of the hypothesis that a milk-borne epidemic of typhoid differs from a water-borne epidemic of the disease in the age and sex distributions of the persons attacked, the authors studied by statistical methods 28 epidemics due to water and 31 due to infected milk, which have occurred in Great Britain and North America.

In the early years of childhood there is no difference in the ratio of male to female patients between the water-borne and milk-borne epidemics. In the later ages of childhood, 5–14 years, there is no change in this ratio in the water-borne group as compared to the ratio at ages 0–4, but in epidemics attributed to milk the proportion of females becomes higher. In the adult years, over 20, the number of male and female patients in water-borne typhoid remains equal, but there is, on the average, a distinct excess of females among the patients of milk-borne typhoid.

In an editorial comment on this study, in the Lancet for September 12, 1936 (page 639), it is suggested, therefore, that a heavier incidence of typhoid cases during an epidemic upon children and, among adults, on females justifies some presumption that milk is at fault. This article, says the editorial, proves that statistics are neither dull nor unintelligible.

J.A.T.

BUTTER

12. Manufacturing Butter of the "Danish" Type. J. M. ROSELL, Provincial Dairy School, St. Hyacinth, P. G.   Can. Dairy and Ice Cream J. *15,* pp. 18 and 61, Pan. and Feb. 1936.

An interesting discussion of the methods for making the "Danish" type or ripened cream butter for the British market is given.   J.C.H.

13. Casein-Formalin Treatment of Butter Boxes. E. G. HOOD, Div. of Dairy Res., Ottawa.   Can. Dairy and Ice Cream J. *15,* 7, p. 47, 1936.

The Casein-Formalin treatment of butter boxes is recommended for overcoming wood taint in storage butter.   The author describes the equipment for spraying and gives formulas for spray material and their preparation and use.   J.C.H.

14. Butter Wraps and Loss of Weight in Prints. A. H. WHITE, Div. of Dairy Res., Ottawa.   Can. Dairy and Ice Cream J. *15,* 8 p. 24, 1936.

A comparison was made of the loss of weight of print butter in storage when wet and dry parchment, "M. A. T. cellophane," and "Pliofilm," manufactured from crude rubber, was used as wrappers.   The weight loss was least for Pliofilm wrappers with slightly the greatest loss for parchment wrappers but no significant differences were found in the weight losses of print butter wrapped in the different wrappers.

No noticeable differences were observed in the surface flavors or the color of the prints in the different wrappers.

At the present time both "M. A. T. cellophane" and "Pliofilm" are more expensive than parchment paper which would be the determining factor for their use for print butter.   J.C.H.

Other abstracts of interest are numbers 1, 4, 6, 26, 31, 32, and 38.

CHEESE

15. On the Behavior of a Few Pencillium-Species, Important in Dairy Technology, Towards Different Organic Nitrogen Sources. KARL J. DEMETER AND RICHARD PFUNDT, South German Res. Inst. for Dairying in Weihenstephan, Tech. College, Munich.   Zentr. Bact. II, *95,* p. 54, 1936.

Some practical experiences led to the belief that the growth of *Pencillium bruneo-violaceum,* a mold very detrimental to camembert cheese, would be promoted in cheeses made from pasteurized milk.   This might be explained by a possible preference for such nitrogen derived from the albumen content of cheeses made from pasteurized milk.   A further practical experience was that cheeses which were oversalted were especially prone to the infection with this mold.

The aim of the authors was to clear up this question by a comparative

investigation on the organic nitrogen requirements of the following molds: *candidum, P. camemberti* and *P. bruneo-violaceum.* The organic nitrogen sources were the following: glykokoll, alanine, leucine, glutamic acid, cystine, peptone, albumen and casein. It was shown that albumen and its derivatives were not good nitrogen sources for *P. bruneo-violaceum* and that this mold was stimulated by peptone and glutamic acid especially if there was no alkaline reaction. This agreed with the practical experience that *P. bruneo-violaceum* thrives on very young cheeses. The destruction of casein was not uniform with the two strains used.

Concentrations of 5–15 per cent of sodium chloride are more detrimental to the true camembert molds than to the *P. bruneo-vioviolaceum.* This confirms the above mentioned practical experience concerning the effect of oversalting. Finally it may be mentioned, that in confirmation of the work of Moser, volutine never could be detected in cultures of *P. candidum,* always with *P. camemberti* and usually also with *P. bruneo-violaceum.* This fact might be used to differentiate between the two species of true camembert molds.   K.J.D.

16. **Butyric and Lactic Acid Fermentation in Silage Fodder.** J. VAN BEYNUM AND J. W. PETTE, Agr. Exp. Station, Hoorn, Holland. Zentr. Bact. II, *94,* p. 413, 1936.

It was shown that in silage made with the addition of inorganic acids, butyric acid fermentation may take place, even if the average pH was less than 3.0 because the different layers with the acid solution were very unequal. The butyric acid fermentation could not take place in a silage of pH 3.0. From pH 3.5 upwards a lactic acid fermentation and a certain type of butyric acid bacilli, *Clostridium tyrobutyricum* always developed previous to the butyric acid fermentation. Therefore a silage in which a lactic and butyric acid fermentation has taken place is likely to cause contamination of milk to producing swelling of cheese.

The authors have further shown that a silage prepared according to the Dutch method always contains butyric acid and that it is always dangerous for cheese making, since in most cases a previous lactic acid fermentation has taken place.   K.J.D.

Other abstracts of interest are numbers 1, 4, 6, 21, and 26.

CHEMISTRY

17. **A Note on the Determination of Iodine in Biological Material.** GLADYS J. FASHENA AND VIRGINIA TREVORROW, Dept. of Pediatrics, New York Hospital and Dept. of Biochemistry, Cornell Univ., Med. College, New York City. J. Biol. Chem. *114,* p. 351, 1936.

A discussion of factors which affect a micro-determination method for iodine in biological materials, and details of an improved technique.
                                                                K.G.W.

18. The Ionization Constants of Calcium Proteinate Determined by the Solubility of Calcium Carbonate. E. G. WEIR AND A. BAIRD HASTINGS, Dept. of Physiology and Lasker Foundation for Med. Research, Univ. of Chicago. J. Biol. Chem. *114*, p. 397, 1936.

The results of this study are consistent with the hypothesis that calcium combines with proteins to form salts which are partially ionized into CA^{++} and protein ions. Further, that an equilibrium exists between these ions and the un-ionized calcium protein salt, which may be expressed by the mass law equation. Determinations of the solubility of calcium carbonate in solutions of casein, serum albumin and serum globulin have been made at 38 degrees for different pH values and protein concentrates. The ionization constants of the calcium salts of these proteins have been calculated and found to have the following values: casein, $pK_{CaProt} = 2.23$; globulin, $pK_{CaProt} = 2.32$; albumin, $pK_{CaProt} = 2.20$.   K.G.W.

19. Calculation of Isoelectric Zones and Isoeletric Points. DAVID I. HITCHCOCK, Lab. of Physiology Yale Univ., School of Med., New Haven, Conn. J. Biol. Chem. *114*, p. 373, 1936.

In this paper the author discusses the significance of curves of the dissociation of simple ampholytes with particular reference to the breadth of the isoelectric zone, the isoelectric points of multivalent ampholytes, and methods of expressing isoelectric points.   K.G.W.

20. The Denaturation of Proteins by Sound Waves of Audible Frequencies. LESLIE A. CHAMBERS AND EARL W. FLOSDORF, Johnson Foundation for Med. Physics and Dept. of Bacteriology and Pediatrices, Univ. of Penn., Philadelphia, Pa. J. Biol. Chem. *114*. p. 75, 1936.

Intense sound waves when applied to certain protein solutions, will cause coagulation. It has been shown by investigation that sound-denatured albumin (protein of lower solubility than that of the native protein) is immunologically similar to denatured albumin prepared in other ways, *e.g.*, by heat in acid, alkaline, or neutral solution, by alcohol, or by acid or alkali. While previous studies indicate that the end-product of sonic denaturation is probably the same as that produced by heating and therefore may be the result of a thermal type of activation, they have not explained the mechanism through which mechanical vibrations may energize the reaction. The authors in this paper report a study of sonic denaturation of certain proteins, first, to compare the end products of the reactions with those produced by other means with respect to chemical properties, and second, to obtain evidence as to the nature of the energy transfer underlying the reactions. Two experimental sonic vibrating units were used in the experi-

ments, one having a resonant frequency of 1200 cycles per second, the other about 9000 cycles per second. With these instruments, egg albumin and plastein were denatured. The solubility of the products under various conditions of pH was the same as for the products denatured by heat. Horse serum albumin, one the other hand, was not denatured by sonic vibration which suggests that the mechanism of the sonic reaction is different from simple thermal activation. K.G.W.

Committee Comments: Sonic vibration is being studied experimentally to homogenize milk, cream, and ice cream.

CONCENTRATED AND DRY MILK

Abstracts of interest are numbers 21, 22, 23, 24, 25, 26, 27, 31, 32, 34, 35, 36 and 38.

FOOD VALUE

21. Lactoflavin, A Necessary Growth-Promoting Factor. S. ANSBACHER, G. C. SUPPLEE AND R. C. BENDER. The Dry Milk Company, Inc., Research Lab., Bainbridge, N. Y. J. Nutrition *11*, p. 401, May, 1936.

Lactoflavin is a necessary growth-promoting dietary factor. A difference in the rate of growth of white rats results from the difference in the daily intake level of pure crystalline lactoflavin varying from 2.0 to 20.0 gamma. The growth-promoting properties of lactoflavin are readily determined with a suitable basal ration adequately supplemented with pure vitamin B and a third factor or group of factors necessary for the prevention and cure of dermatitis and carried by rice polish. The potency of lactoflavin may be calculated to be 150,000 units per gram. However, it is emphasized that there is apparently a discrepancy between the potency of the pure lactoflavin and that contained in natural products. L.A.M.

22. The Iron and Copper Content of Milk Throughout the Season As Related to Anemia Development in Rats. W. E. KRAUSS AND R. G. WASHBURN, Dept. of Dairy Industry, Ohio Agr. Exp. Sta., Wooster, Ohio. J. Biol. Chem. *114*, p. 247, 1936.

Possible variations in the iron and copper content have been suggested as causes for certain nutritional and chemical properties of milk. In this report the authors investigated the iron and copper content of the milk of ten cows, seven Jerseys and three Holsteins, while on various types of rations, both winter and summer.

According to the methods of analysis used, the range in iron content for a period of about one year was 0.34 to 0.43 mg. per liter, and for copper, 0.14 to 0.19 mg. per liter; slightly greater variations were observed in individual, rather than the group analyses. The iron and copper intake when the cows were on dry feed was approximately three times that when they

had access to pasture. This wide range in intake was not reflected in the iron and copper content of the milk.

The rate of anemia development in pairs of rats fed samples of the milk (one pair receiving the milk raw, the other the milk pasteurized at 52.5° F. for 30 minutes) obtained during the course of the study indicate that the biological responses confirm the chemical data; there was not sufficient variation in iron and copper content from period to period to affect appreciably the rate of anemia development. The results demonstrate that no hematopolietic factor destroyed by pasteurization is imparted to milk when cows are under so-called ideal feeding conditions.   K.G.W.

23. The Vitamin C Content of Human Milk and its Variation with Diet. IVA SELLEG AND C. G. KING, Univ. of Pittsburgh, Pittsburgh, Pa. J. Nutrition *11*, p. 599, June, 1936.

The vitamin C content of human milk, as determined by the 2, 6-dichlorophenol-indophenol titration technic, was found to vary from 0.002 to 0.108 mg. per cubic centimeter. The average of fifty-three cases, 3 to 7 days postpartum, was 0.055 mg. per cubic centimeter. On a good hospital dietary without special supplements the average value rose gradually to 0.064 mg. on the tenth day. When the mother was receiving an adequate diet the usual range of vitamin C was in the zone of 0.060 to 0.080 mg. per cubic centimeter in milk. Cases with markedly subnormal antiscorbutic values rapidly approached normal when an orange juice supplement was given. The excess quantities of vitamin were eliminated rapidly in the urine. The investigation provides evidence against the suggestion that humans can synthesize adequate quantities of ascorbic acid during gestation.   L.A.M.

24. Infantile Diarrhoea in Institutions. R. CARTER. Lancet *231*, p. 162, July 18, 1936.

Malted milk in the treatment of enteritis in infants is recommended for its low fat, high carbohydrate value. After stopping all food for 24 hours, it is given in water every three hours in the proportion of 3 tablespoonsful of malted milk to 3 ounces of water. After about a week on the malted milk diet, fresh milk in small amounts or dried milk reliquefied in cream is added in gradually increasing quantities. By this means, the mortality from this disease has been reduced to only 4 per cent.   .   J.A.T.

25. Prevention of Disease by Diet. A. G. MORRISON, S. DATTA AND A. F. WATERS. Lancet *230*, p. 1472, June 27, 1936.

The effect of improvement in diet on the incidence of dysentery and typhoid fever in an English institution is shown in this report.

An outbreak of dysentery in August 1932 resulted in 123 cases, in spite of every effort to isolate patients and prevent the spread of the disease. None of the staff was affected, and examination of milk and water supplies was negative.

A study of the patient's diet showed it to be deficient in protective foods, although the total calories and the first-class protein were more than adequate. Milk, fresh fruits and vegetables, fats, liver and eggs were inadequately provided.

The daily ration of milk was increased by at least 6 oz., and liver and fish were given at least once a week, while fresh fruits and vegetables were added daily. The margarine was vitaminized, and the meat ration was reduced.

Since September 1932 when the improved diet was inaugurated, there has been no case of dysentery and only three cases of enteric fever. From 1918 to 1932 there had been a fairly constant number of cases of typhoid fever, but there were none after 1932.

While these observations apply to only a limited group of patients for a comparatively short time, the authors believe that the results are significant of what may be accomplished when the diet is improved in general quality and vitamin A value in particular. J.A.T.

26. Relative Value of Raw and Heated Milk in Nutrition. E. C. V. MATTICK AND J. GOLDING. Lancet *231*, p. 702, Sept. 19, 1936.

In order to determine the relative food values of raw, pasteurized, and sterilized milks, the authors fed groups of rats on these milks and dry biscuits made of English flour. Five generations were raised on raw milk, three on pasteurized milk, and none on sterilized milk.

The results of this test and another, in which a comparison was made of rats fed on raw milk and on milk pasteurized at 145° to 150° F. (higher than the commercial usage), showed that there were no significant differences in the weights of the animals, nor in their retentions of calcium and phosphorus. Red cells and haemoglobin were also similar in both groups.

A loss of hair amongst rats of the second and third generation on pasteurized milk was, however, shown and is attributed by the authors to a possible deficiency in vitamin B.

Committee Comment: Competent investigators in the United States have raised more than 40 successive generations of healthy rats on diets of pasteurized and dried milk, and whole wheat, with no loss of hair. Apparently some factor is involved other than pasteurization. J.A.T.

27. The Influence of Dextrin and Sucrose on Growth and Dermatitis. R. C. BENDER, S. ANSBACHER, G. E. FLANIGAN AND G. C. SUPPLEE. The Dry Milk Company, Inc., Research Lab., Bainbridge, N. Y. J. Nutrition *11*, p. 391, May 1936.

A study has been made on the prevention of dermatitis in white rats fed a synthetic diet containing pure vitamin B and lactoflavin but no other part of the vitamin B-complex. Comparative data from basal rations containing dextrin and sucrose, respectively, show that no dermatitis resulted

when the former was used, whereas a high incidence of dermatitis resulted when sucrose served as the basal carbohydrate. Vitamin B and lactoflavin supplementing the sucrose ration did not prevent the development of dermatitis, nor did these supplements permit normal and continued growth. Such supplements fed with dextrin promoted a substantial rate of growth. A concentrate prepared from rice polish cured the dermatitis occurring in the sucrose fed animals and at the same time promoted a substantial growth, provided adequate amounts of vitamin B and lactoflavin were fed simultaneously. The occurrence of dermatitis was delayed and was not so regular with a sucrose ration containing 10 per cent hydrogenated vegetable oil as with one containing 3 per cent of the same oil. The data as a whole would seem to indicate that the basal ration containing 69 parts of sucrose and 3 parts of hydrogenated vegetable oil is well suited for the determination of the growth promoting properties of lactoflavin, provided it is supplemented with adequate amounts of vitamin B and the vitamin factor or group of factors contained in the rice polish concentrate.   L.A.M.

ICE CREAM

28. **Using Butter in Chocolate Coatings.** H. A. SMALLFIELD, Dairy Dept., Ontario Ágr. College, Guelph, Ont. Can. Dairy and Ice Cream J. *15*, 1, p. 24, Jan. 1936.

The results of investigations to improve chocolate coatings for ice cream bars are reported. When 35 per cent of the cocoa fat used for thinning the chocolate to the desired consistency for dipping the bars was replaced with butterfat there was a noticeable improvement in flavor and when 50 per cent was used there was a marked improvement. The presence of butterfat produced a somewhat more pliable coating, apparently did not affect the covering capacity of the coating but did increase the cost of the coating.

                                                J.C.H.

29. **Theory and Practice of Ice Cream Making.** HUGO H. SOMMER. Second Edition, p. 639, 1935. Published by the author, Madison, Wisconsin.

This book gives a very clear and comprehensive presentation of the theoretical and practical phases of ice cream making. A discussion of every phase of the subject is given and the book is designed to appeal to the practical ice cream maker, short course and advanced students and research workers.

The second edition published three years after the first edition includes experimental data that have become available since that time. The arrangement of the subject matter has not been changed. The author states in the preface that, "It is gratifying that it has not been necessary to alter or abandon any of the theoretical explanations as advanced in the earlier edition."

A chapter on bacteriology has been added to the new edition. The subject is discussed as it pertains to ice cream and should be helpful in solving bacteriological problems that are encountered in the ice cream plant.

J.C.H.

30. **Suggestions for Making "Candy Flavoured Ice Cream."** C. A. IVERSON, Iowa State College, Ames, Iowa. Can. Dairy and Ice Cream J. *15*, 1, p. 55, 1936.

The author reports on methods of preparing candy for use in ice cream to impart a caramel and butterscotch flavor to the ice cream. J.C.H.

Other abstracts of interest are numbers 8, 21, 22, 23, 24, 25, 26, 27, 34, 35, 36, and 38.

MILK

31. **The Effect of Certain Ingested Fatty Oils Upon the Composition of Cow Milk Fat.** THOMAS PERCY HILDITCH AND HUBERT MORRIS THOMPSON, Dept. of Industrial Chemistry, Univ. of Liverpool, England. Biochem. J. *30*, p. 677, 1936.

It has been known for some time that the administration of cod-liver oil to lactating cows has a depressing effect upon the fat production, as well as other effects upon the physiology of the animal. It has been reported this effect was not observed when the unsaponifiable fraction of cod-liver oil was given in the ration, indicating that the injurious effect was possibly due to the component occurring as triglycerides.

The present investigation shows that some of the highly-unsaturated glycerides of cod-liver oil (but not its palmitoleic acid or the linolenic or linoleic acids of linseed oil) pass into milk fats; and it is suggested that selective absorption of these highly-unsaturated compounds by the enzymes responsible for the elaboration of typical cow milk fat retards their function and causes the depressant effects. K.G.W.

32. **The Effect of Ingested Cottonseed Meal Upon the Distribution of the Constituent Fatty Acids of Goat Milk.** R. W. RIEMENSCHNEIDER AND N. R. ELLIS, Animal Husb. Div., Bur. of Animal Ind. U. S. D. A. Washington, D. C. J. Biol. Chem. *114*, p. 441, 1936.

The fat of goat milk is generally acknowledged to contain greater amounts of capric, as well as caprylic and caproic acids, than does the fat of cow's milk. Certain objectionable qualities have been attributed to the increased amounts of these acids of lower molecular weight. In view of the probabilities of changing the properties of fats by the use of selected rations, as shown by experimental feeding of other animals, the authors investigated the effect of feeding cottonseed meal on the fat constants and presence of component fatty acids of the fat of lactating goats. Preliminary examinations of fat samples collected at the end of four experimental feeding

periods, each of 14 days' duration, indicated a lowering of the saponification number, Reichert-Meissel number, iodine number, water soluble acids, and thiocyanogen number, and an increase in the Polenske value. Partial recovery from the effects of feeding the cottonseed meal ration as the experimental periods progressed was indicated. A study of the fatty acid distribution by the methyl ester distillation method showed an increase in capric, lauric, myristic and stearic acids, chiefly at the expense of palmitic and oleic acids, when the cottonseed meal was fed. A slight lowering of butyric and caproic acids was observed. No evidence of linoleic acid was obtained, although acids of the arachidonic type were found.   K.G.W.

33. **An Apparatus for Milking Small Laboratory Animals and the Composition of Stock Rat Milk.** WARREN M. COX, JR., AND ARTHUR J. MUELLER, Research Lab., Mead Johnson Co., Evansville, Indiana. J. Biol. Chem. *114*, Sci. Proc. XXX, XXII, 1936.

The authors in this abstract report the perfection of a micro-milking apparatus satisfactory for milking rats and guinea pigs. The percentage composition of rat milk at different stages of lactation was determined. The following figures are averages of all determinations: fat, 14.8 per cent; protein, 11.3 per cent; carbohydrate, 2.9 per cent; ash, 1.5 per cent; solids, 31.7 per cent; specific gravity, 1.047; ratio of lactalbumin to casein, 1:12; pH, 6.5 and 6.6. The extracted fat had a saponification number of 221 and an iodine number of 39.9. The size of the fat globules is approximately the same as in cow's milk. Buffer curves show 170 cc. of O.I/N acid (as compared to 65 cc. for cow's milk) to 100 cc. of rat milk are required to lower the pH to 4.0.   K.G.W.

34. **The Effect of Breed Characteristics and Stages of Lactation on the Vitamin C (ascorbic acid) Content of Cow's Milk.** RUSSEL RASMUSSEN, N. B. GUERRANT, A. O. SHAW, R. C. WELCH AND S. I. BECHDEL. Penn. State College, State College, Pa. J. Nutrition *11*, p. 425, May, 1936.

The authors used the 2–6 dichlorophenolindophenol titration method to study the vitamin C content of cow's milk. Cows of the same breed, while receiving similar diets, were found to produce milks which showed wide variations in their ascorbic acid content. Such variations are thought to be due, in part at least, to differences in stages of lactation. Cows of different breeds, while receiving similar diets, produced milks which differed somewhat in their average ascorbic acid values. Of the five breeds studied, the Brown Swiss cows produced milks of the highest, and the Holstein cows produced milks of the lowest ascorbic acid value. Stage of lactation appeared to have a more definite effect upon the ascorbic acid content of milk than did breed differences. The ascorbic acid content of milk was found to be relatively high during the early stages of lactation, but decreased to

a minimum after about two months of lactation, and then increased to a maximum in the later stages of lactation.   L.A.M.

35. The Influence of Milk Constituents on the Effectiveness of Vitamin D. G. C. Supplee, S. Ansbacher, R. C. Bender and G. E. Flanigan, Borden Co., Research Div., Bainbridge, N. Y.   J. Biol. Chem. *114*, p. 95, 1936.

A number of studies have been conducted to ascertain the correlation between "potency" as numerically expressed in terms of "vitamin D rat units" and the clinical effectiveness of cod-liver oil, viosterol, milk from cows fed irradiated yeast, and irradiated milk. It has been recognized in some of these, that irradiated milk possesses a peculiar and marked clinical effectiveness. Various theories have been offered to explain the discrepancy between the empirical laboratory criterion and the clinical results obtained with irradiated milk. The presence of a "vital" factor not measureable by established procedures; a difference in the identity of the vitamin D as obtained from animal and plant sources; the inherent calcium and phosphorus, inherent cholesterol content of milk, and the prosthetic association of the lipid material with lactalbumin, have been suggested or studied as probably explanations for the clinical efficacy of irradiated milk over other vitamin D products.

The authors in this paper, have presented findings which show that certain milk constituents, particularly albumin, affect the response to administrations of vitamin D. Varying amounts of vitamin D in propylene glycol were added to two types of highly dispersed lactalbumin solutions, one consisting of substantially pure protein with prosthetically bound lipid material, the other consisting of the pure protein from which the lipid material was extracted by suitable solvents. Other highly dispersed solutions of lactalbumin and vitamin D were similarly prepared and the protein precipitated, filtered, repeatedly washed, and redispersed. These preparations were fed to properly prepared rachitic rats, the same amount of vitamin D in water being also prepared and administered for comparison. The results show that the healing response from the same amount of vitamin D is significantly intensified when the vitamin is ingested in association with the lactalbumin. The vitamin asociated with the colloid appears to be quantitatively precipitated up to certain limits since the filtrates from these solutions showed no anti-rachitic potency when fed at lower levels, and a greatly reduced potency when fed at higher levels.

When the vitamin D in proplyene glycol was appropriately added to various milks in predetermined amounts, results analagous to those obtained with lactalbumin, were obtained. Breast milk, which could not be activated to any substantial degree by activation, enhanced the effectiveness of the added vitamin, although not to as great a degree as did cow's milk. A

slightly greater effectiveness of standard vitamin D, diluted with olive oil, was observed when fed with milk; the increase in effectiveness was not as great as when the vitamin D was carried in a water miscible solvent. The authors conclude that since the vitamin carried by the lactalbumin showed a greater potency than when fed alone, it appears that the vitamin D and lactalbumin had formed a symplex. A symplex is a system consisting of a prosthetic group and a colloidal carrier of high molecular weight. In view of the experiments, the vitamin D would be the prosthetic group and the lactalbumin the carrier. Since, from the experiments, the lipid free protein vitamin combination induced a greater antirachitic response than the lipid vitamin combination, it is suggested that in the latter the vitamin is merely dissolved in the prosthetic group, namely, the lipid matter associated with the albumin. These observations are presented to explain the effectiveness of certain antirachitic preparations.   K.G.W.

36. **A Study of the Seasonal Variation of Vitamin D in Normal Cow's Milk.** H. ERNEST BECHTEL AND C. A. HOPPERT, Mich. State College, East Lansing, Michigan. J. Nutrition *11*, p. 537, June, 1936.

A method is presented for the concentration of the antirachitic factors in milk fat by extraction with hot alcohol; thus making possible the biological assay of fats of low potency.

The monthly assay of milk fats from several sources, including samples from cows kept in dry lot as well as those pastured, over a period of two years showed that milk may vary as much as 900 per cent in antirachitic potency. Highest values were obtained during July, August, or September and lowest usually in February. Vitamin D values ranging from 4.8 to 43.8 U. S. P. units per quart of milk were observed in the case of Guernsey milk whereas the extreme values for Holstein milk were 3.1 to 27.7 U. S. P. units per quart. The data suggest that the cow has little or no opportunity to store vitamin D during lactation under ordinary dairy management conditions. The close correlation between the antirachitic potency of milk and the amount of available sunshine indicates that the exposure of cows to sunlight is a major factor contributing to the vitamin D content of milk.
                                                              L.A.M.

37. **New Zeland's Municipal Milk Supply.** The Lancet *230*, p. 212, July 25, 1936.

Since 1922 the City of Wellington, the capital of New Zealand, has been operating a municipal milk supply. The milk is purchased from a cooperative dairy farmers' organization. The production area in the summer is 30 miles from the city, and in winter the collection area is extended to 60 miles. The milk is purchased by weight and averages 4.2 per cent butterfat.

Stringent hygienic conditions are enforced by city inspectors, and some

5000 laboratory examinations are made monthly. The milk is pasteurized at 145° F. for 30 minutes, cooled, and bottled. It is retailed in pint, pint and a half, and quart bottles, at an average retail price of slightly over 5 pence (10 cents in U. S.) per quart. About 85 per cent of the city's milk supply comes from the municipal plant, the remainder being sold by about 70 licensed farmers.

The net profit to the city for the year ending March 31, 1936 was 4376 pounds sterling, as against 6132 pounds sterling the previous year. The capital investment was 103,400 pounds sterling, which was raised by loan.

J.A.T.

38. A Study of Alkalies for Bottle Washing. L. R. Bryant (O. A. C. Guelph). Can. Dairy and Ice Cream J. *15*, 3 and 4, pp. 20 and 24, March and April, 1936.

The author's results showed the necessity of applying some form of sterilization treatment, such as chlorine sterilization, to the bottles after they leave the alkali soak tank to obtain consistently low bacterial counts. Recommendations were made for the use of a milder alkali with caustic soda for use in a soaker washer. It was found that one pound of sodium metasilicate, soda ash, or trisodium phosphate, can be used for this purpose to four or five pounds of caustic soda. The combination of caustic soda and sodium metasilicate in the series of experiments produced the cleanest appearing bottles of the three combinations. The addition of sodium metaphosphate to combinations of sodium metasilicate and caustic soda improved the shine. It was found that the total alkalinity of the soak tank solution in terms of caustic soda may be economically maintained between 1 and 2 per cent depending on conditions.

A quick and practical test for "total alkalinity" in terms of caustic soda was devised for frequent plant tests on the alkalinity in the soak tank.

J.C.H.

Other abstracts of interest and numbers 8, 9, 10, 11, 16, 21, 22, 23, 24, 25, 26, and 27.

Journal of Dairy Science

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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Archives of Pediatrics

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Certified Milk

Dairy Produce Review
Dairy World
Deutsche Molkerei Zeitung

Food Industries
Food Manufacture
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Ice Cream Trade Journal
Industrial and Engineering Chemistry

Journal of Agricultural Research
Journal of American Chemical Society
Journal of American Medical Association
Journal of Bacteriology
Journal of Biological Chemistry
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Journal of Dairy Science
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Journal of Physical Chemistry

Kaeseindustrie
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Le Lait

Milchwirtschaftliche Forschungen
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Milk Dealer
Milk Industry

Milk Plant Monthly
Molkerei Zeitung

National Butter and Cheese Journal

Pacific Dairy Review

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

39. Infectious Bovine Mastitis. Report on a Control Program Based on Segregation of Infected Animals. W. N. PLASTRIDGE, E. O. ANDERSON, F. J. WEIRETHER AND R. E. JOHNSON, Storrs Agr. Exp. Sta., Storrs, Conn. JOURNAL OF DAIRY SCIENCE *19*, 10, p. 641, Oct., 1936.

The incidence of streptococci mastitis was greatly reduced in herds of dairy cows segregated and handled on the basis of the extent of the infection.

A.C.D.

40. Observations Relative to the Staining of Micro-organisms Previously Heated in Milk. G. GUITTONNEAU AND JEANNE BRIGANDO, National Lab. of the Dairy Industry, Paris, France. Le Lait *16*, 156, p. 577, June, 1936.

In studying the staining properties of certain lactic organisms previously submitted to a vigorous heat treatment in milk, it was found that the organisms acquired an abnormal resistance to staining by most of the usual techniques such as the gram stain, the classic treatment with aqueous methylene blue, gentian violet, the blue of China and various coloring acids. Some staining can be obtained by the usual techniques by prolonging considerably the period of contact with the dye (10 to 12 hours instead of a few minutes). The staining properties of the organisms in the heated milk become normal again on treating with dilute acid. With such vigorous dyes as the phenic fuchsine of Ziehl, there is scarcely any change in staining properties as a result of heating the milk which contains the lactic organisms. On substituting *B. subtilis* or *B. megatherium* for the lactic organisms in the milk, there is no difference in staining properties as a result of heating the milk. In suspension in milk without subsequent heating, all the organisms mentioned take the dyes easily by the classic procedure, especially by simple treatment with aqueous methylene blue. On treating with methylene blue the lactic organisms appear to be surrounded by a corona. An analogous corona cannot be discerned under the same conditions with *B. subtilis* nor with *B. megatherium*. After staining with the phenic fuchsine of Ziehl and with the acetic acid differentiation, clear coronas are on the contrary visible in all cases.

The particularities of staining that have just been described were found again to a more or less attenuated degree in a series of tests where milk was replaced by pseudo-solution of a complex calcium caseinophosphate. The

resistance to staining with methylene blue did not manifest itself, however, in the case of the lactic organisms heated in lacto-sera where the caseino-phosphate complex was eliminated with rennin. The facts which have been given suggest that a chemical or physical reaction intervenes between the surface layer of the membrane of the organism or the capsule and the other part, a colloidal material from the medium in the nature of a phospho-caseinate. This reaction already beginning at ordinary temperature increases under the influence of heat and terminates or not depending on the case, with the formation of a protective envelope resistant to certain dyes. The nature of the capsulary surfaces in contact with the phospho-caseinates, and the type and cultural state of the bacterial strain submitted to the heat test in the milk will no doubt condition the appearance of the forms of microbiological protection against the action of methylene blue. However, the staining phenomena that have been described may be attributed to other hypotheses—notably to selective adsorption of the dye as modified by the action of heat. A.H.J.

CHEESE

41. A Study of the Egyptian Cheese Called "Mich." G. EL-GERIANY MOSTAFA. Le Lait 16, 155, p. 485, May, 1936.

To curdled skimmilk which has been stirred are added cylinders of curd (from cow or buffalo milk) 6 cm. long by 4 cm. in diameter. The mixture of curd and curdled milk is contained in a clay jar which is sealed with straw and mud. An anaerobic fermentation sets in and at the end of a month the cheese is ready for consumption but the fermentation may proceed for as long as a year. The finished cheese is yellowish white in color, has a piquant taste and the odor is strong due to the high volatile acidity. Bacteriological examination of cold cheese indicates that it is very low in micro-organisms. On progressive aging of the cheese for 1 week, 1 month, 5 months, and 8 months, the pH values were 4.0, 4.5, 4.96, and 5.0 and the volatile acidities were 20°, 22°, 46°, and 60° Soxhlet-Henkel, respectively. A.H.J.

42. Studies on the Emulsifying Salts Used in Processed Cheese. HUGH L. TEMPLETON AND H. H. SOMMER, College of Agr., Madison, Wisconsin. JOURNAL OF DAIRY SCIENCE 19, 8, p. 561, Aug., 1936.

The authors concluded that sodium citrate was probably superior to other salts commonly used to emulsify cheddar cheese. A.C.D.

43. The Bacteriology of Swiss Cheese. W. C. FRAZIER, H. F. LONG, AND WM. T. JOHNSON, JR., Res. Lab., Bureau of Dairy Industry, Washington, D. C. JOURNAL OF DAIRY SCIENCE 19, 8, p. 535, Aug., 1936.

Streptococcus thermophilus cultures improved the quality of Swiss cheese when added to milk with a methylene blue reduction period of more than 5 hours but did not improve the quality when the reduction time was less. A.C.D.

Other abstracts of interest are numbers 45, 48.

CHEMISTRY

44. **The Phospholipids in Milk. IV. Their Chemical Nature and Their Distribution Among Some Milk Products.** GEO. E. HOLM, P. A. WRIGHT, AND E. F. DEYSHER, Divis. of Dairy Res. Lab., Bureau of Dairy Industry, Washington, D. C. JOURNAL OF DAIRY SCIENCE *19*, 10, p. 631, Oct., 1936.

The phospholipids of milk were found to be lecithin, cephalin, and sphingomyelin in the ratio 8.4, 4.5, and 1. The phospholipids contain 4 per cent of phosphorus. Their distribution in dairy products tends to follow the milk fat. A.C.D.

45. **Effect of Salts on the Solubility of Casein and Paracasein.** PAUL F. SHARP AND T. J. McINERNEY, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *19*, 8, p. 573, Aug., 1936.

Sodium chloride and sodium iodide shifted the solubility of paracasein to a more alkaline reaction and make pH 5.5 to 6.0 the region for maximum peptizing action of salt to obtain greatest smoothness in texture. A.C.D.

46. **Accumulation of Protein in the Foam of Skimmilk.** PAUL F. SHARP, ROBERT P. MYERS, AND E. S. GUTHRIE, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *19*, 10, p. 655, Oct., 1936.

The proteins of skimmilk accumulated in the foam in the same proportion in which they occurred in skimmilk. A.C.D.

CONCENTRATED AND DRY MILK

47. **The Determination of Moisture in Powdered Milk by the Toluol Distillation Method.** E. C. THOMPSON AND R. S. FLEMING, The Borden Co., New York and Syracuse, N. Y. JOURNAL OF DAIRY SCIENCE *19*, 8, p. 553, Aug., 1936.

The Toluol Distillation Method of determining the moisture content of milk powder permitted the use of a large sample, the results were secured within an hour, gave accurate results, and was well adapted to plant control work. A.C.D.

48. The Examination by English Specialists of the Synthetic Wool Prepared in Part from Casein. G. GENIN, Paris, France. Le Lait *16,* 155, p. 510, May, 1936.

A comparison is made of some of the properties of genuine wool and the Italian wool said to be made of casein and formaldehyde. On soaking in water, the diameter of the fibres increases to about the same extent in both cases, viz., about 7 per cent. Longitudinally, however, genuine wool increased 1 to 2 per cent while the synthetic wool made from casein increased 7 to 15 per cent. If the synthetic fibre is submitted to a strain after it has been in the water, it elongates considerably, often to twice its original length and the fibre breaks when a force is applied that is only one fourth to one eighth that which is required to break a similarly treated genuine wool fibre of the same diameter. The synthetic fibres were much less resistant to trypsin than were the genuine wool fibres. The synthetic fibres had much the same outward appearance as the genuine wool fibres but had a slightly more rough feeling. Under the microscope, the synthetic fibres were readily distinguishable from the genuine wool fibres. On suspending the fibres in an alkaline solution, about 10 times as much material dissolved from the synthetic fibres as from the genuine wool fibres. The synthetic fibre appeared only to serve satisfactorily in a mixture with more stable fibres of cotton or of viscose for the fabrication of special tissues destined to fill particular needs in the Italian economic situation. It does not appear that the synthetic wool fibres will replace genuine wool fibres except in special cases.   A.H.J.

Other abstracts of interest are numbers, 44, 45, 46, and 61.

FOOD VALUE

49. Vitamin A Activity of Third Cutting Alfalfa Hay as Affected by Methods of Curing. ELLA WOODS, F. W. ATKESON, HARRY WELLHOUSEN, AND R. F. JOHNSON, Idaho Agr. Exp. Sta., Moscow, Idaho. JOURNAL OF DAIRY SCIENCE *19,* 9, p. 581, Sept., 1936.

The vitamin A content of alfalfa hay varied with the method of curing and decrease during storage.   A.C.D.

ICE CREAM

50. Trends in Ice Cream Costs. Special Bulletin No. 53, Statistical and Accounting Bureau, Int. Assoc. of Ice Cream Mfgrs., Washington, D. C., pp. 1–27, Oct., 1936.

In this bulletin the 1935 ice cream expense dollar is analyzed to show the percentage of the total cost represented by each cost item. The cost of the products used in ice cream represents a higher percentage of the total cost than in recent years because (1) products have increased in cost and (2)

production has increased in volume. The ratio of "Novelty" sales to total ice cream sales shows an increase from 1932 to 1935 in the sale of novelties of 30 per cent. It is stated that this increase in the sale of novelties has affected certain costs and must be considered in any such study.   M.J.M.

51. Causes of Defects that Lower the Quality of Our Ice Cream.   J. H. Erb, Ice Cream Field *28*, 5, p. 22, Sept., 1936.

The author briefly discusses the most common ice cream defects giving some of the causes for each.   W.C.C.

52. Advertising Analysis.   Special Bulletin No. 54, Statistical and Accounting Bureau, Intern. Assoc. of Ice Cream Mfgrs., Washington, D. C., Nov., 1936.

The average expenditure for advertising by ice cream manufacturers in 1935 was found to be 2.83 cents per gallon of ice cream. Of the companies reporting, 58 per cent had definite advertising budgets for the following year (1936).

The popularity of the various advertising themes was as follows: quality, 20.6 per cent; food value, 15 per cent; refreshment appeal, 12.2 per cent; health appeal, 11.6 per cent; flavor 10.7 per cent; appetite appeal, 9.1 per cent; confidence in company, 7.5 per cent; seasonal appeal, 7.5 per cent; convenience, 3.5 per cent; economy, 2.3 per cent.

The bulletin contains a detailed analysis of advertising costs and kinds of advertising used in the ice cream industry.   M.J.M.

53. Freezers Used by Wholesale Ice Cream Men in New York State.   R. L. Gillett and D. H. Foster.   Ice Cream Rev. *20*, 4, p. 78, Nov., 1936.

Applications made early in 1936 to the New York State Department of Agriculture and Markets by wholesalers for licenses to manufacture frozen desserts contain information on the number and capacity of "continuous" and "direct expansion" or "batch" freezers.

Of the 218 wholesale plants for which complete figures were available, 23 were equipped with continuous freezers having capacities ranging from 60 to 1,000 gallons per hour. In all but three cases these freezers, representing 10.5 per cent of the plants, had an average annual production of 584,964 gallons per plant in 1935, and made 50.6 per cent of the wholesale ice cream.

In contrast, the 195 plants equipped only with "batch" freezers, included 89.5 per cent of the plants, averaging 67,257 gallons per plant during the year and made 49.4 per cent of the wholesale ice cream.

                                                                    J.H.E.

54. Vital Facts About a Vital Food. Dairy Industry Committee, Washington, D. C. Released by the Int. Association of Ice Cream Manufacturers, Washington, D. C., pp. 1–24, Nov., 1936.

This is an interesting and instructive booklet about milk and milk products. Economic considerations of milk production and distribution are discussed. The manufacture, food value, and distribution of ice cream and other milk products are briefly reviewed. Data as to the milk production, farmers' income from milk, trends in production of agricultural products, etc., are presented in tabular form. The bulletin can be purchased in quantity at a nominal cost and should prove useful to dairy companies with educational programs for consumers.   M.J.M.

55. Formulas for Standardizing Condensed Whole Milk (Before Condensing). C. H. DALE. Ice Cream Field *28*, 5, p. 29, Oct., 1936.

Formulas are given whereby it is possible to adjust the fat and milk solids-not-fat in the product before condensing to that desired in the finished product.   W.C.C.

Other articles of interest are numbers 44, 46, 47, 59, and 61.

MILK

56. The Hygienic Quality of Milk in France. G. THIEULIN, National Vet. School of Alfort, France. Le Lait *16*, 154, p. 337, April, 1936.

Lack of demand for milk of good hygienic quality and the fact that the French farmer does not make milk a very important source of income have not operated to improve the quality of milk as rapidly as desired. The writer suggests steps to be taken in the improvement of the hygienic quality of milk in France. This includes a classification of milk into: Milk A, officially controlled sold raw or pasteurized, the milk to be of exceptionally good quality; milk B, ordinary milk but all of it pasteurized milk; Milk C without guarantee, destined for improvement or rejection. Further improvement of the milk requires education of the producer, economic stimulus in the form of payment for milk on the basis of quality, sanitary, medical or veterinary inspection of the herd and barns where the milk is produced, control of pasteurization, testing of the milk as sold etc. ·   A.H.J.

57. The Law of July 2, 1935, on the Sanitation of Market Milk. A. NEVOT, Chief of the Milk Lab. for Sanitary Veterinary Service of the Seine, Paris, France. Le Lait *16*, 154, p. 383, April, 1936.

A discussion is given of the law which classifies milk into grades, A, B, and C. Grade A milk originates from officially controlled herds and may be used raw or pasteurized. Grade B milk is pasteurized milk from officially

controlled herds; and Grade C milk is raw milk from herds not officially controlled. The quality of the milk in the various grades is considered from the chemical, biological and public health view-points. A.H.J.

58. A Contribution to the Study of Buffalo Milk. Production, Properties, Composition and Derived Products. J. Y. Pissarewsky, Laureate of the Academy of Agriculture of France. Le Lait *16*, 155, p. 465, May; 156, p. 592, June; 157, p. 711, July, 1936.

The fact that there are one sixth as many buffalo in the world as there are cows indicate the importance of the buffalo for milk and meat production and as draft animals. While the milk production of many of these buffalo is small, marked increases in milk yield have resulted where effort has been made and where breeding has been done for this purpose. The chemical composition of buffalo milk is given. · It is characterized chiefly by its high fat content (5 to 17 per cent, average 7.8) and by its high casein content (3.2 to 9.5 per cent). The high fat and casein content of buffalo milk make it especially valuable for butter and for cheese manufacture. The fat of buffalo milk is very bright colored. Cream does not rise by gravity but cream may be readily obtained by centrifugal separation. The preparation of various cultured milks from buffalo milk is described. Buffalo milk is especially suitable for the preparation of yogurt. A comparison of the chemical composition and physical properties of buffalo, sheep, goat and cow's milk is given. A.H.J.

59. The Surface Tension of Milk. W. Kopaczewski. Le Lait *16*, 154, p. 356, April, 1936.

The author discusses the work of Belle on the same subject. The surface tension of pure milk is a fixed value, established around 53 dynes/cm. Dilution has little effect on the capillary constant of milk. The surface tension of skimmed milk is not much different from that of whole milk, being only very slightly higher. During aging, milk shows a distinct increase in surface tension. The agitation of milk is accompanied by an increase in surface tension. A.H.J.

60. The Hygienic Control of Milk. A Practical and Simple Colorimetric Method. Emilio Zapatero, Dept. of Hygiene and Microbiology of the Faculty of Med. of Valladolid, Spain. Le Lait *16*, 157, p. 689, July and Aug., 1936.

Determination of the contamination of milk with colon organisms was used as a criterion of its hygienic quality. Colon organisms were characterized as follows, a short non-capsulated, non-motile, non-spore-forming bacterium with rounded extremities which was a facultative aerobe and negative to the gram strain, does not liquefy gelatin, ferments lactose yielding gas

and acid, slowly ferments dulcite yielding gas and acid, does not ferment saccharose, coagulates milk, causes a color change with phenol red and with neutral red, produces indol in peptone media, is positive to methyl red, and negative to the Voges-Proskauer reaction.   Of the various reactions listed above, fermentation of lactose has been the one most commonly used to determine the presence of *B. coli*.   The author, however, prefers the reaction with dulcite.   This involves the preparation of a medium 10 grams of Liebig's beef extract, 10 grams of peptone and 5 grams of sodium chloride per liter.   This medium is neutralized to litmus with tenth normal sodium carbonate.   Five cc. of a one per cent solution of phenol red (dissolved in tenth normal sodium carbonate) is then added.   To the proper amount (usually 1 cc.) of the above sterile media is added 1 cc. of a sterile solution of dulcite containing 5 milligrams of dulcite.   Sterile physiological saline solution may be added to the culture media.   The proper amount of the milk to be tested is then added and the culture tubes kept at 37° C. (98.6° F.) for 24 hours. ˙ The appearance of a yellow color indicates the presence of colon organisms and the dilution of the milk at which this yellow color develops indicates the degree of contamination.   The use of the dulcite technique instead of the lactose technique appears to be more specific as an indicator of colon organisms originating from fecal material.   A.H L.

61. **The Influence of Method of Sterilizing Equipment Upon Development of Oxidized Flavor.**   A. C. DAHLBERG AND D. C. CARPENTER, New York Agr. Exp. Sta., Geneva, N. Y.   JOURNAL OF DAIRY SCIENCE *19*, 8, p. 541, Aug., 1936.

The development of oxidized flavor in pasteurized milk was accelerated by contact of the milk with a clean copper-alloy metal, especially following chlorine sterilization, but this effect became less as more milk continued to pass through the equipment.   A.C.D.

62. **Marketing Milk in Europe.**   D. H. TILSON, Aluminum Seal Company. Milk Dealer *25*, 12, p. 142–, Sept., 1936.

ʹThe author briefly describes the marketing of milk in Belgium, Denmark, England, Estonia, France, Italy, Netherlands, Norway, Poland, Russia, Scotland, Sweden, and Turkey.   The material for this article was obtained by questionnaires sent to the American Consular ʹService in the above named countries.   C.J.B.

Other articles of interest are numbers 39, 40, 44, 46, 48, and 54.

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SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

62. Quality Butter from the Buyer's Viewpoint. R. L. FEDDERSON, Atlantic and Pacific Tea Co., Chicago, Ill. Nat. Butter and Cheese J. *26*, 9, p. 34, May 10, 1935.

Quality of butter is determined by flavor and aroma, texture or body, salt, and packaging, and of these, flavor is most important. Merchandisers must be familiar with consumers' preference in order to satisfy in each locality the demand for uniformity of color, salt, and general flavor.

The recent government quality campaign has decreased the main defects in flavor and aroma, and should cause greater consumer appreciation and demand. W.V.P.

63. An Analysis of the Oregon Plan of Grading Butter. W. F. JENSEN, Sec., American Assoc. Creamery Butter Mfgrs. Nat. Butter and Cheese J. *26*, 6, p. 8, March 25, 1935.

Butter is graded by the buttermaker on an alphabetical basis. A is 92 score or over, B is 90 and C is 89 or less. One point tolerance is allowed in the score by the state authorities. The Oregon system is not practical in interstate trade because of variations in individual standards, and the perishable nature of butter. Deterioration in quality after grading would make it impossible to guarantee scores and might therefore cause prosecutions of the seller for misbranding. W.V.P.

64. What Happens to Butter Stored at 32° F.? SIDNEY SHEPARD AND H. C. OLSON, Experiment Station, Ames, Iowa. Nat. Butter and Cheese J. *26*, 18, p. 18, Sept. 25, 1935.

Keeping qualities of salted and unsalted butter held at 32° F. and at 70° F. were compared for 14 days. Bacterial changes in both kinds of butter were more rapid at 70° F. than 32° F. but the keeping qualities of salted butter were slightly better than those of the unsalted butter. A total of 233 comparisons indicated that Nile-blue sulphate medium was not as satisfactory for determining total and proteolytic bacterial counts in butter as lactose beef-infusion agar. A list of 18 references is given. W.V.P.

Other abstracts of interest are numbers 65, 80, 81, 82, and 84.

CHEESE

65. Swiss Believe in Dairy Products—and Advertise Them. CHESTER P. HOLOWAY, Nat. Butter and Cheese J. *27*, 3, p. 16, Feb. 10, 1936.

The Swiss Milk Council, Bern, Switzerland, spent $60,000 in 1935 to increase consumption of cheese and other dairy products. Posters, slogans, and direct appeals to grocers, bakers, milk producers and consumers were used.   W.V.P.

66. Good Roquefort Type Cheese Being Made by Minnesota University. Anonymous. Nat. Butter and Cheese J. *26*, 9, p. 8, Jan. 10, 1935.

A discussion is presented of the development of Roquefort type cheese curing in sandstone caves at St. Paul, Minn. Experiments to improve the cheese will be continued.   W.V.P.

67. Cheese Industry Being Developed in Southern States. H. L. WILSON, Bureau of Dairy Industry, Washington, D. C. Nat. Butter and Cheese J. *26*, 2, p. 30, Jan. 25, 1935.

A brief history of the start and growth of cheesemaking in the South.   W.V.P.

68. Various Methods of Manufacturing Cream Cheese. W. V. PRICE, Dept. of Dairy Industry, Univ. of Wis., Madison. Nat. Butter and Cheese J. *26*, 9, p. 18, May 10, 1935.

Three methods of making cream cheese are described. Each method requires clean, sweet, pasteurized milk or cream, clean-flavored, mild-acid, active starter, sanitary equipment and a ready market. Comparison of the three methods states that the Neufchatel method gives a high yield, is inexpensive, and adapted for use in small plant. The cheese is recommended only for local sale since it has a tendency to be crumbly and high in acid. The Geneva method requires a homogenizer and is accomplished without draining. The cheese is very smooth and inclined to be sticky. The cooked-curd method requires a homogenizer, and is widely used in large scale production because of the flavor, body, uniformity, and high yield of cheese per pound of fat.   W.V.P.

69. American and Canadian Tests Show Effectiveness of Vat-Width Curd Knives. E. C. DAMROW, Pres. of Damrow Brothers Co., Fond du Lac, Wis. Nat. Butter and Cheese J. *26*, 12, p. 36, June 25, 1935.

The use of wide curd knives saves more than two pounds of cheese per thousand pounds of milk by reducing losses of curd at cutting.   W.V.P.

Other abstracts of interest are numbers 80, 81, 82, and 84.

CONCENTRATED AND DRY MILK

70. Government Sets Example in Packaging of Dry Skimmilk. Anonymous. Nat. Butter and Cheese J. *26*, 13, p. 22, June 10, 1935.

Dry skimmilk, packaged in one pound sacks of Kraft paper lined with glassine makes an air-proof and water-proof package suitable for sale in stores wherever dry skimmilk is sold. W.V.P.

Other abstracts of interest are numbers 65, 80, 81, 82, and 84.

ICE CREAM

71. Operating Controlled Retail Outlets. FRANK LEGGITT, Iglo Ice Cream Co., Hammond, Ind. Ice Cream Trade J. *32*, 2, p. 25, Feb., 1936.

There are two methods of merchandising ice cream: (1) wholesale manufacturers who serve drug stores, restaurants, confectioners, and other retail outlets, and (2) retail or selling direct to the consumer.

The author states that in this rather fast growth of retail merchandising, it has afforded many advantageous services to the consumer. They are: (1) consumer is served in an attractive, comfortable store, (2) the consumer gets his money's worth, (3) the consumer may have his choice of a large variety of flavors, (4) the fact that all effort and thought is definitely placed on ice cream results in the special care and attention that is conducive to better consumer service.

The operation of retail ice cream stores presents the following complex problems: A product highly perishable, a demand fluctuating not only with seasons but also with daily temperatures, a most unstable employment requirement, a large number of small sales made by a large number of employees, cost problems, sanitation problems, the supply of raw products, advertising and accountancy details.

In merchandising ice cream, we have to develop an acceptance and demand for our product and to encourage the public to eat more ice cream. Solutions to this problem are: (1) Have a product worthy of public favor, (2) a good product in a good store will make good sales, (3) advertising, and (4) store personnel. W.H.M.

72. Eight-Month Sales Index Shows Increase of 6.77 Per Cent. O'NEAL M. JOHNSON, Statistical and Accounting Bureau, International Assn. of Ice Cream Mfgrs. Ice Cream Trade J. *32*, 2, p. 21, Feb., 1936.

The ice cream sales index showing an increase of 6.77 per cent for first eight months of 1935 is based on reports received by the Statistical and Accounting Bureau of the International Association of Ice Cream Manu-

facturers from 709 ice cream manufacturing plants with sales in 1934 of 77,686,737 gallons.

A table is given showing increases and decreases by states for the eight-month periods, January 1 to August 31, 1935, 1934, 1933, 1932, 1931, and 1930. The increase or decrease is expressed in percentage basis compared to same months in the previous year.

May and June normally produce slightly more than one-fourth the sales for the entire year.   W.H.M.

73. **Using Corn Sugar as an Ingredient in the Manufacture of Ice Cream.**
    P. H. TRACY, Univ. of Ill., Urbana, Ill.   Ice Cream Trade J. *32*, 2, p. 30, February, 1936.

Eastern trade demands have raised the sugar content of ice cream mix from 12 per cent up to as high as 18 per cent.   A discussion of the use of cerelose as a partial substitute for the use of other sugars has been given in this article.   It has been assumed that one pound of cane sugar is equivalent to 1.43 pounds of cerelose.   Cerelose was used as 25 per cent of the total sugar content in mixes containing 12, 14, and 16 per cent fat.

Though the study was not complete sufficient data were collected to draw certain conclusions.   The use of cerelose decreases pH slightly, lowers the color of the mix slightly, and the viscosity of the mix is lessened though there was no appreciable difference' in whipping quality.   The data show that cerelose has no tendency to prevent or delay the development of tallowy flavors.   A higher proportion of unfrozen syrups results at any given temperature giving a smoother texture and softer body, but melting faster when exposed to room temperature.   The softer body causes dipping difficulties and low yield unless dipping temperature is lowered one degree for every one per cent of cerelose used.   Consumer tests show that there was little difference in flavor.   Cane sugar ice cream had body preference while ice creams containing cerelose were judged sweeter.   W.H.M.

74. **Pasteurization of the Mix.**   W. H. MARTIN, Kansas State College, Manhattan, Kansas.   Ice Cream Trade J. *32*, 5, p. 19–20, May, 1936.

Advantages gained from pasteurization are: improves the keeping quality of the mix, destroys the harmful bacteria which may be present, dissolves the mix ingredients and makes it possible to meet certain bacteria standards. Also prepares the mix for homogenization and may effect the overrun, flavor, and texture of the ice cream.

Vats should be equipped with flush-type valves, foam heaters, recording and indicating thermometers and an agitating device which will insure thorough mixing of the ingredients.

The pasteurization process really starts with the addition of the ingredients to the vats. A recommended procedure is to place liquid ingredients in the vats first and then add sugar and similar materials. About one per cent of water or skimmilk is sometimes added to the mix to make up for loss by evaporation.

Bicarbonate of soda is added to neutralize the acidity, on the basis that 0.933 pound of soda will neutralize one pound of lactic acid. The soda is dissolved in ten times its weight in water and added to the mix before it reaches 100°.

All ingredients of the mix, except the flavor, should be heated to the desired temperature, usually 150° F. for 30 minutes, and care must be taken to eliminate contamination after pasteurization.   W.H.M.

75. Predicting Dealer Gallonage with a Sales Expectancy Table. Editorial. The Ice Cream Trade J. *32*, 5, p. 44, May, 1936.

An ice cream sales expectancy table based on production figures reported by the United States Department of Agriculture for 1920 to 1934 has been developed. The table can be used to predict the gallonage of a new dealer or it will indicate if a dealer is maintaining his average sales record of previous years, without looking up actual figures.

The method of setting up such a table is carefully explained, and an example of a completed table is given. Due allowance must be made, in using this table, for variations in weather conditions and general business in a territory. The table can be used to best advantage by the ice cream manufacturers who keep accurate records of daily purchases.   W.H.M.

76. Dealer Education as a Means of Eliminating Contamination from Dipper Waters. D. W. HORN, Bryn Mawr, Pa. Ice Cream Rev. *19*, 11, p. 36, July, 1936.

That ice cream dipper waters are frequently sources of bacterial contamination was concluded after studying the laboratory records of counts over a period of six years. In this study, a standard of not more than 100,000 colonies per c.c. was set for dipper waters. The vendor's experience as a food handler had an influence on the bacterial count of the dipper waters. Samples from restaurants were satisfactory in the largest percentage of cases. Next in order were pharmacies, confectioneries and lastly stores. An educational program with dispensers of ice cream is shown to be effective in reducing contamination.   J.H.E.

77. Ice Cream Standards—What Should Be Included in an Ideal Regulatory Law? Editorial, Ice Cream Rev. *19*, 10, p. 40, May, 1936.

There was wide difference of opinion as to what comprise ideal ice cream standards in answer to a questionnaire sent out to ice cream manufacturers

and dairy school faculty members by the Ice Cream Review. The replies received are summarized.   J.H.E.

78. Quality Control in the Manufacture of Ice Cream. A. D. BURKE, Ala. Polytechnic Inst., Auburn, Alabama. Ice Cream Rev. *19*, 11, p. 42, June, 1936.

Important factors in controlling the quality of ice cream are (1) selection of quality ingredients, (2) proper blending of ingredients, (3) careful processing, and (4) laboratory analysis.   J.H.E.

79. Counter Freezers vs. Factory-Made Ice Cream (A Debate). (a) Building Bigger Ice Cream Profits with a Counter Freezer. C. S. CLARK, Secy.-Treas., Counter Freezer Assn. **(b) Sound Merchandising Is the Answer to Profitable Ice Cream Sales.** E. J. FINNERAN, Director of Sales and Advertising, National Dairy Products Corp. Ice Cream Rev. *20*, 1, p. 40, Aug., 1936.

A debate which sums up the pros and cons of the counter freezer and its effectiveness in merchandising ice cream.   J.H.E.

80. Floors for Ice Cream Plants. Anonymous. Ice Cream Rev. *19*, 8, p. 33, March, 1936.

The economical plan to follow when installing floors in an ice cream plant is to put a floor in each department that meets the specific requirements of that department. For these specific needs there are available floors of many different types. The particular advantages and application of various flooring materials are discussed.   J.H.E.

Other abstracts of interest are numbers 64, 70, 81, 82, 83, and 84.

MILK

81. Health Education in the Schools and its Part in Increasing Dairy Food Consumption. CHESTER P. HOLWAY. Nat. Butter and Cheese J. *26*, 12, p. 24, June 25, 1936.

Americans will consume more dairy products if their value is discussed as a part of the educational work in the schools. The need of dairy products in the national diet has been increased during the depression. Surveys in some states indicate that 14 per cent of the families use no milk and little or no other dairy foods. Any long-time program for the betterment of the dairy industry must consider educational work in the schools.   W.V.P.

82. A New Idea in Health Inspection for Employees of Food Plants. F. W. FABIAN, Mich. State College, East Lansing, Mich. The Ice Cream Trade J. *32*, 6, pp. 25–26, June, 1936.

The solution is daily inspection of employees coming in contact with food and dairy products by a nurse, foreman, or some one else every morning before they start to work.

Years of experience would indicate:

1. That every employee should be required to take a complete medical examination by a competent physician semi-annually.

2. That, supplementing the above examination, and as added protection, all employees coming in contact with food, milk, or other dairy products, should be examined.

3. Try to find persons suffering from a contagious disease, and penalize them by discharging or temporarily laying them off.

4. Only people who are inherently clean should be employed in the food or dairy industry. W.H.M.

83. Oxidized Fat Flavors in Milk and Ice Cream. H. H. SOMMER, Univ. of Wis., Madison, Wis. Ice Cream Rev. *20*, 4, p. 40, Nov., 1936.

A review of articles pertaining to the development of oxidized fat flavors in dairy products. J.H.E.

Other abstracts of interest are numbers, 65, 80, and 84.

MISCELLANEOUS

84. Water Supply and Waste Disposal for Dairy Plants. A. M. BUS-WELL, University of Ill., Urbana, Ill. Ice Cream Rev. *19*, 10, p. 42, May, 1936.

Ways of treating water to avoid effect of hardness as well as means of disposing of dairy plant wastes are suggested. J.H.E.

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Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

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United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

85. Abortion Disease and Undulant Fever. R. B. BIRCH, Veterinary College, Ithaca, N. Y. 23rd Annual Report of Intern. Assoc. of Dairy and Milk Inspectors, p. 51, Oct., 1934.

Brucella melitensis, Brucella suis, and *Brucella bovis* are all pathogenic to man and probably in the order named.

Brucella suis may cause disease in cattle, but as far as known *Brucella bovis* does not cause disease in swine.

It has been found that following infection it requires time for the agglution titer to build up. Most reactions appear between the third and eighth week following exposure. To eliminate the disease from herds it is necessary to test and remove all reactors and then repeat the process until no new cases appear. Once a herd is clean, purchases must be made from a clean herd. It is not safe to buy non-reacting animals from a herd that has reactors in it. L.H.B.

86. The Detection and Control of Mastitis. D. H. UDALL, Veterinary College, Ithaca, N. Y. 23rd Annual Report of Intern. Assoc. of Dairy and Milk Inspectors, p. 35, Oct., 1934.

More than 90 per cent of mastitis cases are believed to be due to *Streptococcus agalactiae.* It is doubtful, however, if the disease could be controlled altogether by the elimination of this organism. The disease can be established in a mastitis-free herd by insanitary methods of milking and stabling. The author prefers the bromthymol-blue test, using test tubes in preference to blotter. He also recommends that teats be dipped in chlorine solution (200 to 400 p.p.m.) after milking. L.H.B.

87. Laboratory Control Methods for Country Plants. F. E. A. SMITH. 23rd Annual Report of Intern. Assoc. of Dairy and Milk Inspectors, p. 13, Oct., 1934.

Comparisons were made on 564 samples of milk of the standard agar plate count, the direct microscopic count, and the methylene blue reduction time with the actual keeping quality.

Milk that would remain sweet to the taste for 15 hours at 72° F. was considered satisfactory for pasteurizing. Milk which would withstand this incubation with less than .01 per cent increase in titratable acidity was considered excellent. L.H.B.

88. Use of Chlorine in the Dairy Products Plant. J. W. YATES, General Lab., Inc. Nat. Butter and Cheese J. *27*, 1, p. 25, Jan. 10, 1936.

After discussing the types of chlorine compounds the author states that the effectiveness of chlorine treatments decreases with decreasing amounts of available chlorine, with increasing amounts of organic matter, with increasing pH and with decreasing temperatures.   W.V.P.

89. Practical Aspects of B. coli in Pasteurized Milk and Milk Products. CHARLES PALEY, Certified Lab., Inc., New York, N. Y. Milk Dealer *26*, 2, p. 38, Nov., 1936.

A brief discussion of the significance of *B. coli* in dairy products. Possible causes of large numbers of this organism being found in pasteurized milk and milk products are also set forth.   C.J.B.

BUTTER

90. Use of Starters in Quality Butter Production. F. W. BOUSKA, Beatrice Creamery Co., Chicago, Ill. Nat. Butter and Cheese J. *26*, 23, p. 8, Dec. 10, 1935.

A moderate amount of lactic and citric fermentation is necessary for the production of quality butter. This fermentation improves the aroma and, in the manufacture of sweet cream butter, the lack of this fermentation may be responsible for some surface flavors. The aroma in starter caused by diacetylmethyl-carbinol may be increased by adding citric acid to the skimmilk. Sixty-two pounds of skimmilk valued at 55 cents plus 0.093 pound of citric acid valued at 2.7 cents gives a starter with double the aroma of the same amount of ordinary starter.   W.V.P.

91. White Butter—A Challenge to the Dairy Industry. M. E. PARKER, Butter Quality Supervisor, Sealtest System Labs., Inc. Nat. Butter and Cheese J. *27*, 5, p. 10, March 10, 1936.

The natural yellow color of butter is a good approximate indication of its nutritional value. The yellow color of milk fat depends on the presence of the yellow pigment carotene which the animal converts into vitamin A. Since vitamin A is necessary in the diet, the industry should not encourage the production of white butter of inferior vitamin A potency.   W.V.P.

92. Good Carton Design Will Help You Sell Your Butter. Anonymous. Nat. Butter and Cheese J. *26*, 5, p. 22, March 10, 1935.

Explanation of the importance of shape of package is illustrated with diagrams. Methods of attracting consumer attention such as color, recipes on the carton, design, and printing are discussed. It is suggested that the details of package design be left with experts in this field of merchandising.   W.V.P.

93. Dairyman Gives Advice on Farm Butter Making. L. H. Burgwald, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bul. No. 21, p. 41, Dec. 17, 1936.

Steps to be taken in order to insure good quality farm butter are described. Good feeding, cleanliness, frequent churning at the proper temperature, incorporation of salt, and proper working of the butter are practices that must be followed. It is suggested that butter for storage is best made from pasteurized sweet cream into rolls or prints and immersed in a saturated brine solution. W.E.K.

Other abstracts of interest are numbers 88, 121, 122, and 124.

CHEESE

94. Wisconsin's Italian Cheese Industry. Anonymous. Nat. Butter and Cheese J. *27*, 17, p. 34, Sept. 10, 1935.

Italian cheese in Wisconsin is made chiefly by Italians. About a dozen operators produce approximately 1,000,000 pounds per year of at least 15 varieties. Names and locations of operators are given. W.V.P.

95. Relative Merits of Canning and Packaging American Cheese. Anonymous. Nat. Butter and Cheese J. *26*, 5, March 10, 1935.

During the past few years, extensive experiments have been conducted in the manufacture of cheese to meet the consumer's demand for packaged goods. Canned cheese is being used because there are no weight or moisture losses and the product is rindless. Other less successful types of packages are described. W.V.P.

96. How Milk Quality Was Improved in Ohio Swiss Factories. Prof. Kern K. Schellenger, Dept. of Dairy Technology, Ohio State University, Columbus, Ohio. Nat. Butter and Cheese J. *26*, 17, p. 39, Sept. 10, 1935.

Common causes of poor quality milk were found to be: Inefficient cooling, dirty equipment, careless and wet hand milking, diseased cows and poor delivery facilities. The improvement work demonstrated that it is possible in the laboratory to pick out the source of the trouble by use of the methylene blue test and direct microscopic counts followed with a fermentation test. The work was done in the summer of 1932 and included 25 cheese factories and 1200 to 1500 producers. The work shows that milk quality can be improved at low cost and with little effort. W.V.P.

97. A New Type of Cheese Solves Problem of American Maker. Anonymous. Nat. Butter and Cheese J. *27*, 3, p. 18, Feb. 10, 1936.

The Barron Co-operative Creamery, Barron, Wisconsin, is successfully making and merchandising a new type of cheese by using pasteurized milk, pure cultures and a patented process. W.V.P.

98. Practical Observations on the Yield of Cheese in Cheese-making.
E. VAILLANT. Le Lait *16*, 154, p. 360, April; 155, p. 486, May,
1936.

There is much cheese of second and third grade produced in France.
This is due to faulty methods of cheese-making. A formula is presented by
which the yield of cheese from milks of various total solids contents can be
calculated and tables are given showing the yields of cheese to be expected
at various moisture contents determined by type of cheese to be made.
Methods are also given for calculating the anticipated yield where a par-
tially skimmed milk is used in the cheese-making operation. Reasons for
discrepancies in cheese yield above and below the calculated values are dis-
cussed. An analysis of the cheese serum will usually indicate the reason for
the discrepancy in yield. Thus if the cheese yield is lower than the antici-
pated value, the serum may be cloudy and abnormal in composition due to
the incomplete action of the rennin because of insufficient quantity or
quality of the rennin, or improper conditions for its action. If the serum
is normal, the cheese yield may be low due to too great a loss of water from
the curd because of an abnormally high temperature while the rennin is
acting. The yield of cheese may also be higher than calculated. This is
usually due to conditions attending the action of the rennin in the milk.

<div align="right">A.H.J.</div>

Other abstracts of interest are numbers 88, 122, and 124.

CHEMISTRY

99. The Determination of Chlorides in Milk. A. MASSOT AND H. LESTRA.
Le Lait *16*, 157, p. 723, July–Aug., 1936.

Into a 100 cc. graduated tube are introduced 10 cc. of milk, 3 cc. of a
5 per cent solution of metaphosphate, and 60 to 70 cc. of water. After agi-
tating, 10 cc. of tenth normal sulphuric acid are added and the volume made
up to 100 cc. The liquid is again shaken and then filtered. To 58.5 cc. of
the clear filtrate are added 5 to 6 cc. of nitric acid and 5 cc. of tenth normal
silver nitrate. The liquid is boiled for 5 minutes and then allowed to cool.
Ferric alum is then added and titration with tenth normal potassium sul-
phocyanate conducted in the usual way.

Where it is desired to avoid the filtration step, the organic matter in the
milk (except the fat) may be oxidized with potassium permanganate and
nitric acid. To 10 cc. of milk are added in order, 5 cc. of tenth normal
silver nitrate and 20 cc. of saturated potassium permanganate solution. The
liquid is brought to a boil while being well stirred. To the hot liquid are
then added 40 cc. of nitric acid. The liquid is boiled again until clear. For
best results it is important to add the reagents in the order given and to
accord the boiling procedure prescribed. The titration with potassium sul-
phocyanate is then conducted on the clear liquid as described below. A

third method for determining chlorides in milk is also described. Into a 100 cc. graduated flask are added about 60 cc. of a mixture of denatured alcohol and acetone (3 parts of chloride-free alcohol to 1 part of acetone) and 10 cc. of milk, the milk being added drop by drop. The volume is made to 100 cc. with the alcohol-acetone mixture. The liquid is then filtered on a folded filter, the first filtrates being returned until a clear filtrate is obtained. To 75 cc. of the filtrate are then added 5 cc. of nitric acid and 5 cc. of tenth normal silver nitrate and some ferric alum. Titration is then conducted in the usual way with tenth molar potassium sulphocyanate. Of the 3 procedures described, the one using the alcohol-acetone mixture as the precipitating agent was considered the most desirable as it was the most rapid and gave a sharper color change in titrating.   A.H.J.

100. An Investigation on the Determination of Urine in Milk. LASCAR BURURIANA, Lab. of Biological Chem. and Vet. Medicine of Bucharest. LeLait *16*, 157, p. 697, July–August, 1936.

While no case of dilution of milk with urine has been reported, it is thought that this may be due to the difficulty of detecting such dilution. Thus the density and index of refraction of milk are not changed even in milks containing 30 per cent of urine. Work was accordingly done to develop a method by which small amounts of urine could be detected in milk. The method finally devised depends on the determinations of the creatinine content of milk. Because urine contains about 120 times as much creatinine as does milk, the presence of as little as 1 per cent of urine can readily be detected.

The determination of creatinine was conducted as follows: 20 cc. of the milk and 50 cc. of water are placed in a 100 cc. graduated flask. Ten cc. of 20 per cent copper sulphate and 10 cc. of a suspension of calcium hydroxide (prepared by slaking 200 grams of quicklime and making the final volume to 1000 cc.) are added and water is then added to the mark and the flask shaken vigorously for 2 to 3 minutes. The shaking is important in that it allows the obtaining of a clear filtrate in sufficient quantity which filters rapidly. Twenty-five cc. of the filtrate are then placed in a 50 cc. graduated flask and 5 cc. of a saturated solution of picric acid and 2 cc. of a 10 per cent solution of sodium hydroxide are added. The flask is allowed to stand for 10 minutes, and water then added to the mark, the flask agitated again and let stand for 5 minutes after which the liquid is filtered into a clean dry flask. The first filtrate is returned to the filter until a perfectly clear filtrate is obtained. Color comparisons may then be made with standards but use of a Duboscq colorimeter or a photoelectric colorimeter is suggested. The latter is especially recommended. In using the photoelectric colorimeter, standards for color comparison are not necessary. A curve of light absorption as a function of concentration has been constructed and it

was established that absorption is a linear function of concentration for small quantities. Use of the copper-lime precipitating reagent removes not only protein but lactose, the latter of which would interfere with the picric acid determination of creatinine. Moreover, 65 per cent of the creatinine is precipitated by this reagent. This being a constant, a correction may be made in calculating the creatinine content of the sample.

Using the procedure that has been given, it is possible to detect as little as 1 per cent of urine in the milk. Milk containing this quantity of urine will have approximately twice as much creatinine as normal pure milk.

<div align="right">A H J</div>

101. **A Practical Test for Pasteurization.** HAROLD W. LEAHY, Dept. of Health, Rochester, N. Y. 23rd Annual Report of Intern. Assoc. of Milk and Dairy Inspectors, p. 93, Oct., 1934.

This method is based upon the fact that amylase (as pointed out by Rothenfusser in the JOURNAL OF DAIRY SCIENCE, 1932) in milk is completely inactivated by proper pasteurization at 143° F. for 30 minutes.

The author reports the detailed procedure and states that the presence of as little as 1 or 2 per cent of raw milk can be detected in pasteurized. Also insufficient heating and holding can be detected.   L.H.B.

CONCENTRATED AND DRY MILK

102. **The Grading of Dry Milk Solids.** Anonymous. American Dry Milk Institute, 221 North La Salle St., Chicago, Ill., 1936.

This 21-page booklet specifies the requirements for the three grades of dry skimmilk; 1, Extra, 2, Standard, and 3, Third as adopted by the American Dry Milk Institute. The methods of analyses are given for moisture, butterfat, solubility, foreign sediment, flavor, and bacterial content.

The term "dry skimmilk" as used in the literature to designate the "not-fat-solids" of milk has been changed to the term "dry milk solids (not over 1½ per cent fat)."   A.C.D.

103. **When Creamery Powders Skim Milk, How Should Patrons Be Paid?** L. C. THOMSEN, Dept. of Dairy Ind., Univ. of Wisconsin, Madison. Nat. Butter and Cheese J. *26*, 5, p. 18, March 10, 1935.

When the milk, skimmilk or buttermilk from high-testing herds is dried at a milk plant or creamery the distribution of the returns to the patrons on the basis of the fat content of the milk is frequently criticized as being unfair. Milk low in fat contains more solids not fat per unit of fat but milk which is rich in fat contains less water per unit of solids not fat. An equitable system of payment is proposed. It is suggested that a factor which varies with the composition of the milk be used to compensate for variations

in milk composition and drying costs. A table of factor values is given and calculations are shown in detail to explain the system. W.V.P.

Other abstracts of interest are numbers 88, 99, 100, 104, 105, 111, 122, and 124.

FOOD VALUE

104. Calorific or Energy Value of Milk. A. E. PERKINS, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Agr. Exp. Sta. Weekly Press Bul. No. 21, p. 34, Oct. 29, 1936.

When comparing normal cow's milk of other fat tests with 4 per cent milk it is found that the energy value is reduced by 15 per cent for each per cent of reduction in fat test below 4 per cent, and increased by 15 per cent for each 1 per cent increase in fat above 4 per cent. When a 3.5 per cent base is used, each per cent of increase in fat content above 3.5 is equivalent to a 16.2 per cent increase in the energy value of the milk. Protein increases about 42 per cent as rapidly as the fat, and lactose only about 3 per cent as fast. W.E.K.

105. Vitamin C in Milk Is Unstable. W. E. KRAUSS AND R. G. WASHBURN, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bul. No. 21, p. 29, Sept. 24, 1936.

Chemical determinations for vitamin C in milk showed but a small loss (5 to 15 per cent) of this factor when the determinations were made shortly after pasteurizing or boiling. On standing at room temperature, however, boiled or pasteurized milk may lose as much as 50 per cent of the original vitamin C within 6 hours. W.E K.

ICE CREAM

106. First Four-Month Index Shows 11.37 Per Cent Sales Increase. O'NEAL M. JOHNSON, Statistical and Accounting Bureau, Intern. Assoc. of Ice Cream Mfgrs. Ice Cream Trade J. *32*, 8, p. 17, Aug , 1936.

Statistics, compiled by the Statistical and Accounting Bureau of the International Association of Ice Cream Manufacturers, from 651 ice cream plants in the United States with sales in 1935 of 79,451,114 gallons, show a 11.37 per cent increase for January 1, to April 30, 1936.

Increases for the first four months by months:

January	10.91 per cent
February	4.15 per cent
March	15.60 per cent
April	12.33 per cent

W.H.M.

107. License for Dairy Plant Workers Suggested as Safety Measure. F. W. FABIAN, Michigan State College, East Lansing, Michigan. Ice Cream Trade J. *32*, 8, p. 25, Aug., 1936.

To summarize the points which this paper emphasized it is suggested:

(1) That all employees in dairy and dairy manufacturing plants be licensed.

(2) In order to obtain such a license, that they be required to pass not only a health examination but also an examination on milk hygiene.

(3) That proper instruction be given the applicants for such licenses by the board of health or colleges, or by both.

(4) That the operator license be required in addition to the license to operate a dairy or dairy manfacturing plant within a city.

(5) That a very nominal sum be charged for the operator's license. The license should be for control and educational purposes only and not as a means of raising revenue.   W.H M.

Other abstracts of interest are numbers 87, 88, 89, 91, 99, 100, 101, 102, 104, 105, 108, 119, 122, and 124.

MILK

108. Effect of Sunlight on Some Milk and Cream Products. F. J. DOAN AND C. H. MYERS. Penn. Agr. Exp. Sta., State College, Pa. Milk Dealer *26*, 1, p. 76, Oct., 1936.

The authors describe an experiment determining the effect of sunlight on some milk and cream products when exposed in paper containers as compared with clear glass bottles.

The following conclusions are drawn:

Paper milk bottles, of the type used in this study, offer appreciable protection to skimmilk, whole milk and buttermilk· against the action of sunlight in causing burnt flavors as compared with clear glass bottles, but are no protection to whole milk and cream of homogenized whole milk and cream against tallowy flavors caused by sunlight.

Blue- and green-colored paper bottles or blue and green cellophane wrappers on paper bottles retard the development of tallowiness and burnt flavor in skimmilk, whole milk, cream and buttermilk.

When milk is exposed to sunlight in paper bottles and in clear glass bottles, "off" flavors are detectable first in the glass bottles.

The degree of tallowy flavor produced in milk and cream by sunlight appears to be greater in the paper than in the clear glass bottles.

The burnt and tallowy flavors caused in milk products by exposure to sunlight appear to be distinct flavor changes, the former predominating in low-fat products and the latter in high-fat products. In whole milk exposed to the sun both flavors commonly occur together.

Homogenization of milk and cream accelerates the development of tallowy flavor due to copper catalysis.

The burnt flavor caused by sunlight apparently has its source in the casein-free and albumin-free serum of the milk.

The bleaching effect of sunlight on milk and skimmilk is primarily due to a fading in color of the serum pigment, lactoflavin, and there seems to be a coincidence between such fading and burnt flavor.

Milk exposed to sunlight in paper bottles exhibits no appreciable bleaching of color or fading of the serum pigment.

The serum pigment shows no appreciable fading in milk when tallowy flavor is developed through copper catalysis.   C.J.B.

109. The Cost of Producing Milk. C. F. MONROE, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bul. No. 21, p. 32, Oct. 15, 1936.

The amounts of feed (under winter conditions) required to produce 100 pounds of 4 per cent milk were as follows: grain, 39 pounds; hay, 38 pounds; and corn silage, 114 pounds. When only hay and grain were fed it took 43 pounds of grain and 64 pounds of hay to produce 100 pounds of 4 per cent milk. It is estimated that the cost of this feed represents 50 per cent of the cost of milk production.   W.E.K.

110. Dairymen Suggest Problems for Marketing Research. C. G. Mc-BRIDE, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bul. No. 21, p. 40, Dec. 10, 1936.

As a result of interviews it was found that dairymen are interested in obtaining further information on the following marketing practices: the testing of milk for butterfat, trucking in the country, the base and surplus plan, methods of arriving at the price to be paid producers, and the information supplied to the producer by the dealer.   W.E.K.

111. Feeding Color into Milk. W. E. KRAUSS, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bul. No. 21, p. 20, July 23, 1936.

The relation between intake of carotene and carotene output in milk from the various breeds is discussed.   W.E.K.

112. Production of Milk and Cream of Low Bacterial Count. Milk Dealer *26*, 2, p. 68, Nov., 1936.

A discussion of why it is difficult to produce milk and cream of low bacterial count. The discussion includes the following divisions: (1) Raw milk, (2) delivery, (3) equipment in the plant, (4) methods of control, (5) types of organisms in the milk, and (6) the place the consumer holds in regard to the quality of the milk.   C.J.B.

113. What Can Be Done to Increase Per Family Milk Sales. Milk Dealer *26*, 2, p. 48, Nov., 1936.

Re-analyzing the data of the Consumer's Council survey, which showed

that regardness of family size, daily purchases of milk are consistently around two quarts per family; the American Dairy Foundation suggests the following possibilities upon which milk dealers might profitably spend some thought:

1. Family size containers—despite previously noted objections.
2. Greater promotion of fresh concentrated milk.
3. A family carrier to hold four quarts (one gallon) of milk in regular present style bottles. This might be of cardboard, one service package, or a wire or metal carrier to use both ways.
4. Greatly extended emphasis on use of milk in the kitchen, distribution of recipes in easy-to-use form.   C.J.B.

114. An Efficient Layout for a Small Dairy Plant. Milk Dealer *26*, 2, p. 46, Nov., 1936.

Plans for a plant handling 400 quarts of milk daily.   Operating expenses for the year 1935 are also given.   C.J.B.

115. These Delivery "Leaks" Can Be Prevented. A. E. FRIEDGEN, Transportation Consulting Engineer. Milk Dealer *26*, 2, p. 42, Nov., 1936.

The author enumerates nearly 100 preventable delivery leaks which are present in nearly every fleet of trucks.   C.J.B.

116. What the Consumer Can Expect in a Bottle of Milk.

W. E. KRAUSS,
Dept. of Dairy Husbandry, Ohio Agr. Exp. Sta., Wooster, Ohio. Milk Dealer *26*, 2, p. 34, Nov., 1936.

The author answers two questions.   1. In comparison with other food. products, does the consumer get his "money's worth" when he buys milk?. 2. What can the consumer expect in the way of food value when he purchases a quart of milk?   C.J.B.

117. Current Trends in Milk Consumption—April to July, 1936. EDWARD FISHER BROWN, Milk Research Council, Inc., 22 East Fortieth Street, New York City.   Milk Dealer *26*, 1, p. 72, Oct., 1936.

The author gives a comprehensive report of the performance of the fluid milk market in metropolitan New York, Boston, and Philadelphia during the period April to July, 1936.   C.J.B.

118. Small Dairies Showing Largest Profit, Retail Survey Indicates. Milk Dealer *26*, 1, p. 68, Oct., 1936.

A report is given of the 1936 retail survey of 53 milk distribution companies of varying size by Dun and Bradstreet, Inc.   C.J.B.

119. Off-Favored Milk. A Problem of Animal Nutrition. J. A. ANDERSON, Rutgers Univ., New Brunswick, N. J. Milk Dealer *26*, 1, pp. 60–66, Oct., 1936.

A description of feeding experiments to determine whether a difference in flavor could be produced in milk (1st) by substituting field-cured alfalfa of good quality for machine-cured alfalfa, (2nd) by feeding carrots, and (3rd) by feeding a carotene-high ration.

The author states that the following points appear to have been established by the experiments. Machine-cured alfalfa hay and carrots contain a factor or factors necessary for the production of milk of good flavor, the lack of which appears to be the cause of certain off-flavors. Field-cured alfalfa may become deficient in this factor. Hay of good color is much richer in whatever is necessary for milk of good flavor than is field-cured alfalfa devoid of color. Since both rancid and oxidized flavors were eliminated by the same additions to the ration, and both flavors again developed when the inferior rations were fed, it is reasonable to assume that both types of off-flavor are due to the same dietary deficiency. In all experiments a period of several to nine days elapsed between improvement of ration and improvement in milk flavor. Off-flavors did not develop until a longer time elapsed after a deficient ration was substituted for a rich ration.

The information accumulated thus far does not permit us to say specifically which substance in the ration is necessary for the production of milk of good flavor, or whether more than one substance is involved, which would seem very likely. All indications point to carotene as being very important in this connection. C.J.B.

120. Paying Route Salesmen. Milk Dealer *26*, 1, p. 50, Oct., 1936.

A summary of the results obtained in a survey made by the Milk Dealer for the purpose of securing some information on methods of paying salesmen.

Twenty-one reports were secured from milk dealers in 14 representative states and the District of Columbia. Of these 22 representative dealers, 13 advised that they paid their routemen on a flat commission basis. Five advised that they used a part commission and part salary system of payment, while only four used the straight salary only on wholesale routes and one used the straight salary only on some of his routes while he used the commission system on part of his routes. Only one of the four was entirely on a straight salary basis and that was against his wishes.

The comments of the various dealers on their systems of paying route salesmen are also presented. C.J.B.

121. A Method of Preparing Churned Cultured Buttermilk. C. L. ROADHOUSE AND E. E. BROWN, Univ. Farm, Davis, California. Circular 339, Univ. of California, Berkeley, 1936.

Skimmilk is pasteurized at 185° F. for one hour and then promptly cooled

without recontamination.   Sweet cream is pasteurized separately at 145° F. for 30 minutes.   Sufficient pasteurized cream is added to the skimmilk to make a mixture testing 0.75 per cent and approximately 1 per cent of good starter added.   When the acidity has developed to between 0.70 and 0.80 per cent the culture is drawn into the churn.   Approximately 0.5 ounce of salt for each 10 gallons of milk, if necessary, a small amount of butter color is added.   This mixture is churned at a temperature which will give butter granules about the size of a pinhead in from 6 to 10 minutes.   The churned milk is removed to a coil vat and pasteurized sweet cream added.   The amount of cream should be sufficient to increase the fat content of the mixture to 1.5 per cent.   The milk is then cooled to 40° F. or below and held several hours to permit thickening and the escape of air bubbles before bottling.

The method, if accurately followed, will give a buttermilk in which the rising of the butter granules and the "wheying off" is reduced to a minimum and in which both the body and flavor are improved.   D.H N.

122. The Method of Closing Jugs, Pots or Pans of Milk. G. BARTHELEMI, Hygienic Lab. of the Univ. of Brussels. Le Lait *16*, 157, p. 705, July–Aug., 1936.

Principles involved in constructing milk cans in order to prevent foreign material from getting into the milk at the closure are discussed.   The use of rubber to make a better seal was found satisfactory but not practical due to injury to the rubber during manipulation of the can in the usual dairy operations.   Increasing the diameter of the usual milk can lid and proper slope at the perimeter of the lid gave a cover which largely prevented contamination of milk with foreign material.   A.H.J.

123. Certified Milk. HUGH L. DWYER, Kansas City Medical Milk Commission. Milk Dealer *25*, 12, p. 121, Sept., 1936.

The author explains the origin and development of the certified milk industry and discusses the possibilities of its production for smaller cities.   C.J.B.

124. Advertising Dairy Products in Australia. S. M. BALLANTYNE-RUSSELL, Goldberg Advertising Pty., Ltd., Melbourne, Australia. Nat. Butter and Cheese J. *27*, 2, p. 16, Jan. 25, 1936.

Butter, milk and cheese have been advertised very little.   Condensed and powdered milk have been advertised only during the past five years. Annual per capita consumption of milk approximates 42 gallons; of butter, 30 pounds; of cheese, 3.82 pounds.   Liberal use of meat tends to keep cheese consumption down despite advertising of processed brands.   W.V.P.

Other abstracts of interest are numbers 85, 86, 87, 88, 89, 91, 99, 100, 101, 104, 105, and 107.

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Biochemical Journal
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Canadian Dairy and Ice Cream Journal
Certified Milk

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Milk Dealer
Milk Industry

Milk Plant Monthly
Molkerei Zeitung

National Butter and Cheese Journal

Pacific Dairy Review

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

125. New Germicidal Rays Retard Mold Growth. Ice and Refrig. *19*, 1, p. 1, July 1936.

The Westinghouse Lamp Co., Bloomfield, N. J. has announced a new low-wattage gaseous conductor device which produces radiations germicidal to mold spores in the air. Its trade name is Sterilamp. It consists of a slender glass tube containing a small quantity of special gas. Electricity sent through the tubes produces the germicidal rays. Thus far the apparatus has been used only in the process of "tenderizing" meat. The cost of operation is low, and air passing through ducts where the lamps are located reaches a high degree of sterility. The radiations tend to kill houseflies after several minutes' exposure, and fruit-flies, roaches, grain weevils refuse to enter the area of exposure. The article makes no mention of any effect upon human beings.   L.C.T.

126. Studies on the Bactericidal Action of Bovine Whole Blood and Serum Towards Brucella Abortus and Brucella Suis. M. R. IRWIN, B. A. BEACH AND F. N. BELL, University of Wisconsin, Madison. J. Inf. Diseases *58*, p. 15, Jan.–Feb. 1936.

Experiments were conducted on cattle that had recovered from infection with *Brucella abortus* and on those that had not been infected in the hope that differences might be found in the bactericidal action of blood or serum from the two groups of animals and that the resistance of an animal to infection might be predicted from a test on the bactericidal action of the blood.

It was found that bovine serum normally contains bactericidins for *Brucella abortus* and is slightly more active in this respect than the corresponding whole blood. There is a difference between animals in bactericidal activity of serum or blood, but each animal showed uniformity in reaction at different times. The animals that had recovered from a previous infection with *Brucella abortus* showed a loss in the bactericidal properties of the blood as compared to that of presumably normal animals.

Bovine whole blood exerted no bactericidal effect on *Brucella suis* and the serum had less effect than on *Brucella abortus*.   W.C.F.

127. Comparative Observations on Streptococci from Human Gastro-Intestinal Ulcerations and from Bovine Mastitis. JOHN C. TORREY AND ELIZABETH MONTU, Cornell University Medical College. J. Inf. Diseases *58*, p. 105, Jan.–Feb. 1936.

"A comparative study was made of authentic strains of the Bargen

diplo-streptococcus of ulcerative colitis, of selected enterococci associated with the same disease, of representative strains of Saunders' streptococcus of gastro-duodenal ulcers and of streptococci associated with bovine mastitis.''

''Biochemical and serological tests indicated only exceptionally any relationship between the streptococci associated with ulcerative processes in the human gastro-intestinal tract and *Streptococcus mastitidis* of bovine origin. On the other hand, three streptococcal strains from mastitis milk not related culturally or serologically to *Streptococcus mastitidis*, exhibted such relationships to two enterococcus strains from ulcerative colitis and to certain of the Saunders peptic ulcer and carcinoma strains. These and other findings suggest a bovine origin for certan enterococcus-like organisms capable of invading human tissues.''   W.C.F.

128. Clinical Aspects of an Outbreak of Typhoid Fever. S. W. SMITH. Lancet *231*, p. 1450, Dec., 1936.

In August and September, 1936 an outbreak of typhoid fever occurred in three neighboring communities in Dorset and Hampshire, England. During the course of the epidemic there were 523 reported cases and 41 deaths.

The cause of the epidemic was an infected raw milk supply from one dairy. On August 22nd this milk was pasteurized, and in three weeks the outbreak had ceased.

Since the epidemic was milk-borne, children were the greatest sufferers, the disease being most common among those between the ages of 10 and 35.

The author discusses the symptoms, prognosis, and treatment of the disease. Pure milk is the principal food employed in building up the patient.   J.A.T.

BUTTER

129. Testing Cream and Butter for Extraneous Matter. ROBERT P. MYERS, AND RANDALL WHITTAKER, Am. Creamery and Poultry Prod. Rev. *79*, 15, p. 502, Feb. 13, 1935.

For preparation of butter samples for filtration and sediment test the authors advise that either N/20 hydrochloric or sulfuric acid is preferable to 4 per cent borax solution. For filtering, 100 x 100 nainsook cloth from fibers 6/1000 of an inch in diameter was found best. The size cloth considered best is 1.8 square inches or a circle 1½ inches in diameter. No sediment tester now on the market contained all the desirable features such a tester should have. Sediment discs may be mounted wet on cards and filed in envelopes of cellophane or plioflim or on small squares of glass. P.S.L.

130. A Cream Denaturant. W. F. JENSEN, Am. Creamery and Poultry Prod Rev. *79*, 9, p. 293, Jan. 2, 1935.

In order to color condemned cream, the author recommends the use of

erythrosine, a certified food color, at the rate of one gram for ten gallons of cream. The color is harmless. It costs $17.00 per pound, this amount being sufficient to color 4540 gallons of cream.   P.S.L.

Other abstracts of interest are numbers 125, 134, 139, 140, 141, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, and 155.

CONCENTRATED AND DRY MILK

Abstracts of interest in the concentrated and dry milk industry are numbers 125, 131, 134, 137, 139, 140, 141, 143, 144, 145, 146, 147, 148, 149, 151, 152, 153 and 154.

FOOD VALUE

131. Vitamin G Concentrate. G. C. Supplee, Borden Co., New York City, Am. Creamery and Poultry Produ. Rev. *80*, 10, p. 317, July 10, 1935.

Dr. Supplee's announcement of the production of the first concentrate of vitamin G is important to health authorities interested in the prevention of pellagra. This disease is common to the South, the number of cases in 1932 amounting to 15,643 and deaths 4,134. Principal sources of vitamin G have been yeast and liver. Vitamin G is shown to consist of two components, one identified as lactoflavine, the growth promoting factor, and the other, as yet unnamed, is considered the anti-pellagra factor. The two may be isolated from whey or concentrated whey. Lactoflavine is present in whey to the extent of 3 to 5 parts per million. The presence of vitamin G is determined by ultra violet rays, the product in a dark room showing a brilliant yellow fluorescence, even in minute quantities. To date whey appears to be the cheapest source of the vitamin.   P.S.L

ICE CREAM

132. The Association's Year. Robert C. Hibben, Intern. Assoc. Ice Cream Mfgrs., Washington, D. C. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *1*, p. 19, Oct. 1936.

The work of the International Association of Ice Cream Manufacturers is herein outlined. The association attempts to serve a twofold purpose; one is the direct service it gives to the association members and the other the service rendered to the industry as a whole. During the past year one of the main activities of the association has been to work in the interests of the ice cream industry whenever Federal or State legislation affecting the industry is pending.

Another function of the association is to work with the National Bureau of Standards for simplified practices regarding ice cream cups, cartons, cans, and brick molds.

During the past year the Merchandising Bureau of the Association was changed to a separate corporate body to be known as the Ice Cream Merchandising Institute, Inc. The regular publication of the Merchandising Institute is the "Spinning Wheel." Two other publications of "Merchandising Helps" have been issued during the year.   M.J.M.

133. What's Ahead for our Industry? W. R. CAMMACK, Crescent Creamery Co., St. Paul., Minn. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs., *1*, p. 30, Oct. 1936.

The volume of ice cream sales for the past year was the highest since 1929. Against this the cost of ingredients has increased and the tax burden has become heavier. A program of education by the industry is suggested as a means of acquainting legislative bodies as well as the public with the relation of the industry to the farmer and the consumer.

The new Revenue Laws, the Social Security Act, and other pieces of legislation make it imperative that a good system of accounting be used by all manufacturers. The Uniform System of Accounting of the International Association of Ice Cream Manufacturers meets this need.   M.J.M.

134. Drought and the Dairy Outlook. H. A. Ross, The Borden Co, New York, N. Y. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *1*, p. 34, Oct. 1936.

The dairy outlook for 1932 and 1936 is compared. In 1932 practically every factor tended toward an oversupply of milk with a consequent low cost for the raw products used in ice cream mix. The number of milk cows was increasing and consumption of dairy products was decreasing. This situation brought about price cutting and distress sales.

The situation in 1936 is much improved. The cow cycle reached its peak in 1934 and has since declined about 5 per cent. For the next few years there will be a decrease in the ratio of cows to the population consuming dairy products. Employment in the manufacturing industries has risen 34 per cent since 1932. Payrolls have increased even more than re-employment. These and other indices point to a greater demand for dairy products and a higher raw products cost for ice cream manufacture. The ice cream maker can expect less competition from low priced ice cream. On the other hand, he must be alert, otherwise the cost of raw products will increase more rapidly than his selling price, thus wiping out profits.

                                                          M.J.M.

135. The Kentucky Ice Cream Tax. CARETON BALL, Hughes and Co., Lexington, Ky. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *1*, p. 52, Oct. 1936.

A tax of 28 cents per gallon was placed on ice cream by the state legislature of Kentucky in May, 1936. A comparison of ice cream sales in Ken-

tucky since the passage of the tax law with sales in neighboring states not so affected indicates a loss of approximately 50 per cent in sales of commercial ice cream. An association for repeal of the ice cream tax was incorporated in June, 1936. The association has two suits in the courts against the tax; one is so drawn that it can be carried to the United States Supreme Court if necessary.

Committee comments: This law has been repealed. M.J.M.

136. Modern Methods in Ice Cream Making. H. C. GUILD, Vilter Mfg. Co., New York City. Ice and Refrig. *91*, 3, p. 230, Sept. 1936.

The object of the paper is to describe that part of the ice cream industry which is of interest to the refrigerating engineer. Interesting historical information is included. A readily understandable discussion of operating difficulties in connection with direct expansion freezers is given. The advantages of stage compression are pointed out. The volumetric efficiency of compressors is clearly and simply described. L.C.T.

Other abstracts of interest are numbers 125, 131, 134, 137, 139, 140, 141, 143, 144, 145, 146, 147, 148, 149, 151, 152, 153 and 154.

MILK

137. Maintaining the Freshness of Milk. The Hofius Process. Milk Industry *17*, p. 45, Nov. 1936. (This article was an abstract from Deutsche Bergwerks Zeit. of Oct. 11, 1936).

The process discussed in this paper was discovered by Hofius in 1935 and deals with the preservation of milk by placing it under a pressure of ten atmospheres of oxygen. By this procedure it is claimed that milk could be kept fresh for at least five and one-half weeks.

The process consists of placing milk in stainless steel tanks admitting oxygen under ten atmospheres' pressure and shaking the container. The oxygen, together with the atmospheric air, is allowed to escape from an outlet cock; then a second charge of oxygen under a pressure of ten atmospheres is admitted and retained.

Milk that has received no pretreatment prior to the treatment with oxygen must be stored at a temperature not exceeding 8° C. in order to retain its freshness.

Professor Richter, of Kiel University, discovered that a pre-treatment of heating the milk to 58° C. for three hours would enable the milk to retain its freshness regardless of storage temperatures.

It is also stated that pre-treated and pressure treated milk retains its freshness after leaving the container for about twenty-four hours longer than will milk treated according to present day accepted practices.

In Venezuela, milk tanks filled by this process and used on ships

travelling to Africa and twice crossing the equator were found to have their milk contents unchanged after several weeks.

The process is covered by forty-one patents.

Committee Comments: There are several American patents that have been granted for the preservation of milk with oxygen. Patent (U. S.) No. 361045, dated April 12, 1887, and No. 1007046, dated Oct. 31, 1911, pertain to the use of oxygen under pressure. Patent No. 626486, dated June 6, 1899, relates to a process in which both oxygen and carbon dioxide are used under pressure.

The preservation of milk under carbon dioxide pressure is described in a Bulletin 202 of the New York Agricultural Experiment Station, 1907.

<div align="right">L.H.B.</div>

138. What is Wrong with Milk Distribution? Lancet *231*, p. 1406, Dec. 12, 1936.

In a review of the Report of Reorganization Commission for Great Britain, issued by the Ministry of Agriculture and Fisheries, the Lancet points out that milk marketing boards have done excellent work but their full utility cannot yet be assessed. Producers and distributors have benefitted, but the retail cost to consumers has been raised, despite a slight increase in consumption, which has been meager in view of the efforts conducted to stimulate the use of milk.

The commission proposes that a permanent milk commission of five members be created to develop the industry, fix prices, and control any State milk subsidy, and it recommends that such a subsidy be granted to enable liquid milk prices to be relieved from their part payment of manufactured articles.

The commission's report is criticized for failure to realize how intimately the safety of milk is involved in its greater production and use, and for failure even to mention pasteurized milk. "Whatever methods are adopted for marketing milk," said the Lancet, "the position will remain unsatisfactory until a safe milk-supply is provided."   J.A.T.

139. Keep Cans Clean and Sterile. M. W. YALE, Geneva, N. Y. Am. Creamery and Poultry Produ. Rev. Vol. *80*, 10, p. 317, July 10, 1935.

In the production of low count milk, it is unnecessary to resterilize milk cans at the farm if the dealer, milk hauler, and dairy farmer cooperate properly. This cooperation consists of thorough washing, steaming, and drying at the plant, prompt delivery by the hauler, and prompt removal of can covers and inversion of the cans and storage in a dry place away from dust by the farmer. By following this procedure cans will add no more than 10 bacteria per cubic centimeter to milk. Handled otherwise the count may be increased by millions.   P.S.L.

140. Beet Tops and Milk Flavor. G. M. Trout and G. E. Taylor, Michigan Agr. Exp. Sta. Quarterly Bul. Vol. 18, 1, Aug. 1935.

In this study 1700 samples of milk from cows fed beet tops were examined. The flavor was affected noticeably when 25 pounds or more of beet tops were fed and in those cases where the tops were fed alone. Aeration of milk reduced the off flavor and pasteurization changed the character of the flavor. The off flavor of milk produced by feeding beet tops was especially disagreeable only in those cases where excessive quantities were fed, where the tops were of poor quality, or where frozen. It would seem, from this study, that when good feeding practices are followed, no trouble need be experienced from the normal feeding of good quality beet tops.

P.S.L.

141. Influence of Acids, Cleaners, Sterilizers, and Brines on Metals. O. F. Hunziker, Blue Valley Creamery Co., Chicago, Illinois. Am. Creamery and Poultry Prod. Rev. 80, 15, p. 494, August 14, 1935.

The author discusses metals, plated metals, metallic alloys and metallic veneers used in dairy equipment. Glass enamels and 18–8 stainless steels are recommended. For removal of milk stone the author advises washing the utensil at 150° F. with water containing one-half of one per cent tartaric acid. Corn sugar is also a solvent of milk stone and may be so used. As dairy sterilizers only the slow-setting hypochlorites may be safely used on the usual metals used in equipment. Copper appears to be the best metal known for resistance to corrosion by brine. Tendencies toward corrosion may be reduced to a minimum by adding caustic soda until the brine becomes slightly alkaline. The addition of sodium chromate will further reduce brine corrosiveness.

P.S.L.

142. Flavored Milk Drinks vs. Flavored Water Drinks. M. O. Manghan, American Dairy Foundation. Am. Creamery and Poultry Prod. Rev. Vol. 79, 25, p. 912, April 14, 1935.

In this summary of advantages of milk drinks over other soft drinks, milk distributors are advised to sell chocolate milk in competition with the soft drinks but not in competition with whole milk; to partially defeat the milk in order to compete in price with soft drinks; and to use prepared syrups so as to insure uniformity of flavor, speed the processing, and the elimination of spoilage.

P.S.L.

Other abstracts of interest are numbers 125, 126, 127, 128, 131, 134, 143, 144, 145, 146, 147, 148, 149, 151, 152, 153, and 154.

MISCELLANEOUS

143. Trends in Industrial Taxation. Ellsworth C. Alvord, Washington, D. C. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. 1, p. 40, Oct. 1936.

A thorough presentation of Federal receipts and expenditures, and re-

cent developments in taxation, is given in this paper. The author predicts higher levels for industrial taxation in the near future.   M.J.M.

144. The Robinson–Patman Law. EDWIN B. GEORGE, Dun and Bradstreet, New York City. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *1*, p. 62, Oct. 1936.

The provisions of the Robinson–Patman Law and their effect on business are discussed with considerable detail in this paper.   M.J.M.

145. Accomplishing Results in Employer-Employee Relations. WALTER B. WEISENBURGER. National Association of Manufacturers, New York City. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *1*, p. 83, Oct. 1936.

The National Association of Manufacturers is attempting to improve employer-employee relationships. One method now employed is a public information program by means of the press and radio. The other is to educate the employee about his relationship to the industry which he serves.   M.J.M.

146. New Air Conditioned Dairy Plant at Houston, Texas. Ice and Refrig. *90*, 5, p. 349, May, 1936.

A brief description of the new $200,000.00 plant includes the dairy machinery as well as the air conditioning equipment.   L.C.T.

147. Fibrous Glass For Insulation. Ice and Refrig. *90*, 5, p. 365, May, 1936.

The Corning Glass Company after eleven years of research has been able to manufacturer a well felted flexible mass resembling cotton but possessing the chemical stability characteristics of glass. The fibres have a diameter ranging from 1/7 to 1/50 of that of human hair. The thermal coefficient ranges from 0.266 B.T.U. per sq. ft. per degree F. per hour per inch of thickness at 70° F. mean temperature and 1½ lbs. per cubic foot, to about 0.60 B.T.U. at the higher temperatures for which the material is recommended and 6 pounds per cubic foot density. The material is acid proof (except for hydrofluoric), vermin proof, weather proof, and will withstand temperatures up to 1000° F.   L.C.T.

148. Air Cleaning Equipment and its Operation. H. C. MURPHY, Am. Air Filter Co., Louisville, Ky. Ice and Refrig. *91*, 1, p. 67, July, 1936.

This is an interesting résumé of investigations on air pollution and its influence on health. Data are included giving the kind and amount of dust in the air of various cities. Specifications are included for satisfactory air filters and their use, as well as brief descriptions of various types of equipment.   L.T.C.

149. Methods and Systems of Defrosting. Ice and Refrig. *91*, 2, p. 25, Aug., 1936.

Ice and Refrigeration carries only a brief review of a paper presented by Siegfried Ruppricht, consulting engineer of N. Y. city, at the spring meeting of the A. S. R. E. In the original paper, twenty different methods of defrosting and nine different methods of controlling them were described. Some are listed below:—

1. Picking and scraping.
2. Increasing pressure in the evaporator and releasing it suddenly.
3. Spreading brine over frost, and washing away.
4. Pouring water over thickly frosted coils.
5. Use of electric heaters.
6. Shutting circulation off the frosted coil.
7. Reversing the cycle. L C.T.

150. Securing Carbon Dioxide with Converters. Roy E McIlrath, Stanley Knight Corp. Ice and Refrig. *91*, 5, p. 355, Nov., 1936.

An interesting side line to dry ice is the use of converters for securing a cheap, pure carbon dioxide gas for any purpose. The price of dry ice has steadily declined during recent years because the production of this commodity has increased from 340,000 lbs. per year in 1925 to 230,000,000 lbs. in 1935, and because its production has become a by-product of many plants. Whereas dry ice can be purchased at 3 cents per lb. in 50 lb. lots, liquid carbon dioxide is selling for 6 cents per lb. The difference in cost is largely due to handling charges and overhead. L.C.T.

151. An Analysis of Absorption Systems. A. B. Stickney. Ice and Refrig. *90*, 5, p. 322, May, 1936, *90*, 6, P. 395, June, 1936, *91*, 1, p. 3, July, 1936, *91*, 2, p. 93, Aug., 1936.

The first of the series of four articles includes a chart giving the thermal properties of ammonia-water solutions. The chart is the result of conversion into English units from data reported by German investigators.

The second article includes a diagram of a simple absorption system as well as tables showing conditions existing at each point of the cycle. A detailed discussion of the thermodynamics of the system is included.

The third article continues the discussion begun in the second, covering combinations of auxiliary, and a derivation of complete heat balance as a guide to method of analysis.

The last article includes a discussion of the advantages of the compound cycle. L.C.T.

152. The Cold Storage Locker Business. Ward E. Guest. Ice and Refrig. *91*, 4, p. 280, Oct., 1936.

During the past five years approximately 1500 cold storage locker plants have been put into use. To give adequate service to its patrons, a plant must have an adequate chill room with full butchering equipment, a sharp

freeze room with a temperature of $-10°$ F. It should also be equipped for curing meat. This room should be kept between $36°$ and $38°$ F. Lockers should be provided with built in locks and should also be removable for cleaning. Entrance to lockers should be so arranged that the attendant may see everyone who comes and goes, so that no unfrozen products are placed in the lockers. The cutting room may well serve as an ante-room to the lockers. Cold storage plants may be operated in connection with local dairies.   L.C.T.

153. New Diesel Power Unit Reduces Operating Costs. Ice and Refrig. *91*, 5, p. 401, Nov., 1936.

A brief description is given of a 4 cylinder 77 hp. caterpillar Diesel unit in a combined creamery and ice plant at Pittsfield, Ill. A table of operating costs indicates that on a limited output of 9 tons ice per 24 hours with purchased power, the cost per ton of ice was $2.74, whereas in the present setup with capacity of 14.4 tons per 24 hours the cost per ton of ice is $.85 due to lesser power fluctuation. Additional savings result from the use of the Diesel engine for generating power for the dairy plant.   L.C.T.

154. Carbon·Dioxide in Its New Field of·Usefulness. J. C. GROSSMAN. Ice and Refrig. *90*, 2, p. 147, Feb., 1936, *90*, 3, p. 219, Mar., 1936, *90*, 4, p. 289, Apr., 1936, *90*, 5, p. 359, May, 1936, *91*, 1, p. 58, July, 1936, *91*, 2, p. 137, Aug., 1936, *91*, 3, p. 218, Sept., 1936, *91*, 4, p. 304, Oct., 1936, *91*, 5, p. 304, Nov., 1936.

This is a continuation of a series of articles, publication of which was temporarily suspended in July, 1931. Developments since that date are covered. A great mass of historical information as well as patent data are included. A description is given of absorbers and compressors as well as diagrams of installation together with technical data on operation. The thermodynamics of carbon dioxide as used in refrigerating equipment is discussed. Economies of CO_2 refrigeration are pointed out. Line drawings for quantity production of low temperature liquid CO_2 are given. The terms enthalpy and enthropy are discussed. Absorbers and absorbents in production of CO_2 are described and evaluated.   L.C.T.

155. The Karlsruhe Cryogenic Institute. J. S. GOOSEMAN. Ice and Refrig. *91*, 5, p. 394, Nov., 1936.

The report reviews the work of the above Institute for the past ten years, and points out that its activities are divided into:—

1. Physiological, chemical research.
2. Refrigerating machinery and equipment.
3. Application of low temperature.
4. Problems of the refrigerating industry.

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L.C.T.

JOURNAL OF DAIRY SCIENCE

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

156. Van Oijen Modification of the Frost Little Plate Method. A Critical Investigation of Van Oijen's Test for the Bacterial Content of Milk Samples. H. BARKWORTH, South-Eastern Agr. College, Wye, Kent. J. Dairy Research *8*, p. 244, Sept. 1936.

The Van Oijen test makes possible an estimate of small numbers of organisms in milk and is used in Holland for the official control of "certified" milk.

The colony counting error of the Van Oijen test was found to be about the same as that of the plate count.

From the results of quintuplicate tests it is recommended that 24 hours incubation at 28° C. be used for the Van Oijen test and 72 hours at 37° C. for the plate test.

Thirty-one low count samples (3000–30,000 per ml.) and thirty-one high count samples (30,000–300,000 per ml.) were tested in quintuplicate by both methods, and statistical examination of the results shows that at both levels of count the Van Oijen test is significantly more accurate.

In the Van Oijen test the results are based on a larger amount of milk than the plate test and it is held that in comparing various methods of assessing the numbers of organisms in milk the size of sample may have a great effect upon accuracy.   H.A.B.

157. A Pigment-Producing Organism (Pseudomonas Sp.) Isolated from Discolored Butter. E. R. HISCOX, National Inst. for Research in Dairying, Univ. of Reading. J. Dairy Research *8*, p. 238, Sept., 1936.

An organism causing a dark discoloration in butter containing 0.38–0.55 per cent salt was studied. At 15° C. a brownish color developed and diffused through the medium. At lower temperatures this was mixed with a blue-black pigment, insoluble in water, brine, chloroform, ether, ethyl and methyl alcohol, butterfat, and dilute sulphuric and acetic acids, but soluble in formalin. During growth of the organism the blue-black pigment was excreted from the cells and deposited as irregular aggregates of platelets varying considerably in size and shape. The nature of the source of the nitrogen influenced the development of this pigment, proteose appearing to be inhibitory. The brown pigment produced at higher temperatures may probably be attributed to the action of ammonia produced by the organism.

The organism, a rod with rounded ends, non sporing, actively motile and gram negative was regarded as a species of Pseudomonas. In litmus milk it

produced alkalinity with bleaching and digestion at all temperatures up to 30° C. At 1–3° C. the action was very slow, a dark ring developing to a depth of about ½ inch. No growth was obtained on standard agar, yeast-dextrose agar, beerwort agar, bean agar and potato. The first two media became satisfactory for growth with the addition of ½ per cent NaCl. With 5 per cent NaCl growth became very scanty.   H.A.B.

158. **Biennial Review of the Progress of Dairy Science. Section E. The Disease of Dairy Cattle.** S. J. EDWARDS, The Hannah Dairy Research Inst, Kirkhill, Ayr.   J. Dairy Research *8*, p. 291, Sept., 1936.

The literature regarding chronic streptococcus mastitis, contagious abortion and tuberculosis is reviewed—64 references are cited on mastitis, 90 on contagious abortion and 52 on tuberculosis.   H.A.B.

BUTTER

159. **Changes in Acetylmethylcarbinol Plus Diacetyl Content of Butter.** WALTER L. SLATTER, Graduate Student, Iowa State College, Ames, Iowa.   Nat. Butter and Cheese J. *27*, 20, p. 20, Oct. 25, 1936; 21, p. 18, Nov. 10, 1936.

The aroma of butter is due to the presence of diacetyl, the source of which is acetylmethylcarbinol. The sum of both substances in butter is an indication of the extent of desirable flavor development. The acetylmethyl-carbinol plus diacetyl ($Amc + Ac_2$) was studied to determine the amounts produced and the factors influencing its production in salted and unsalted butter. All but one lot of butter was made from neutralized and pasteurized sweet cream to which was added butter culture. The culture contained added citric acid. Measurements of $Amc + Ac_2$ were made at intervals after churning. The following conditions favored or accompanied the production of $Amc + Ac_2$: unsalted butter; high temperatures of storage; decreasing pH; the use of 10 to 20 per cent culture; and the addition of citric acid fermenting streptococci to the cream. A decrease in $Amc + Ac_2$ occurred after the maximum was attained although the presence of salt tended to retard this decrease. Variations in production of $Amc + Ac_2$ were attributed to differences in cultures.   W.V.P.

160. **How American Creamerymen Advertise Butter.** (Anonymous.) Nat. Butter and Cheese J. *27*, p. 6, Nov. 25, 1936.

A survey of butter manufacturers shows that 88.88 per cent of those responding use the newspaper and store signs as advertising media. About one-third of the advertising dollar is spent in newspapers, and one-quarter in store signs. Other media include the radio, house organs, outdoor advertising, street car signs, calendars, pencils, and other means. Relative impor-

tance of types of advertising and expenditure on each type are shown in tables. Advertising must be backed by quality of product. W.V.P.

161. Studies in Surface Flavour in Butter. W. H. SPROULE AND F. W. HAMILTON, Dept. of Dairying, Ont. Agr. College, Guelph. Can. Dairy and Ice Cream J. *16*, p. 19, Feb., 1937.

This problem was studied from the standpoint of contamination of the butter by wash waters.

In studies of the chlorination of wash water it was suggested that the concentration of chlorine may properly vary from 5 to 10 p.p.m. depending upon the organic content of the water.

The filter used in the test was an efficient means of removing bacteria from water provided it was properly operated.

Nevertheless, there was no correlation between filtration of wash water available in these experiments and the keeping quality of butter.

J.C.H.

162. Starter vs. Non-Starter Butter. C. H. PARSONS AND F. W. BOUSKA. Am. Creamery and Poultry Prod. Rev. *81*, p. 364, Jan. 8, 1936.

Manufacturers of butter, in many cases, have doubted whether the cost of starter is justified by the results it produces in butter. Results secured in one hundred trials showed that the addition of starter to neutralized cream increased the score from 0.2 to 0.5 of one point and that the keeping quality of butter made with starter was somewhat better. It was possible to make a more uniform butter by the use of starter and to produce a more desirable flavor. Starter improved the butter from a 90–91 score cream to a greater extent than from 89 score cream. Whether this beneficial effect is great enough to warrant use of starter is a problem, the answer to which must be decided by local conditions.

Supplementing Mr. Parson's observations, Mr. Bouska advised that his observations convinced him of the improvement of butter through the use of starter. This improvement in keeping quality he believes to be due to the presence of lactic acid and suggests for satisfactory butter a pH range of 5.8 to 6.8. To reduce the cost of starter two alternatives are mentioned: (1), using half the usual amount of starter plus 0.15 pounds citric acid per 100 pounds starter; and, (2), working starter into the butter at working, and at the rate of no more than two to eight pounds per 1000 pounds of butter. P.S.L.

163. Analysis of Data fom National Butter Scoring Contest of 1934. S. L. TUCKEY AND P. H. TRACY. Am. Creamery and Poultry Prod. Rev. *81*, p. 844, April 8, 1936.

This article gives a detailed analysis of results secured in the 1934 annual butter scoring of the American Creamery Buttermaker's Association. Prac-

tically all fresh entries, 94.7 per cent, were made from sweet cream. In the storage class 93.5 per cent of the entries were made from sweet cream. With fresh butter samples, 83 per cent were made with cream testing 0.18 of 1 per cent, or under, acidity, and with storage butter 78 per cent. Several samples were neutralized but in most cases the initial acidity of the cream was so low as to make comparisons with the usual conditions impossible. No difference in keeping quality could be noted from the use of starter. Quality appeared to be due chiefly to the quality of the raw cream used.   P.S.L.

Other abstracts of interest are numbers 157, 168, 171, 179, 181, 184, 185, 188, and 189.

CHEESE

164. Consumer Preferences for Cheese. ASHER HOBSON AND MARVIN A. SCHAARS, University of Wisconsin, Madison. Wis. Agr. Exp. Sta. Research Bul. 128, Oct., 1935.

University dining halls offered 650 students several kinds and qualities of cheese. Preferences were determined by per capita consumption. First choice of men was mild American, of women processed American. Other choices indicated lack of discrimination when compared with trade standards of quality. Among 6770 adult customers in retail stores in six cities, 48 per cent chose mild rather aged American samples which were offered to them to taste; 61 per cent chose processed American over aged American, women decidedly preferring the processed American; ⅔ chose processed to natural Brick; and 55 per cent men and 63 per cent women selected processed over natural Swiss. Farm residents showed a greater preference for processed cheese. Mild, aged and processed American cheese was served to selected groups in non-university dining rooms day after day to see if original tastes would change. If processed was not chosen early in the 12 to 15 weeks' period of the test it eventually was consumed in the largest amounts. Some menus stimulated consumption of cheese. Interview with hotel managers and consumers showed personal reaction toward cheese as a food; the economy of cheese; ways of using it; and buying practices. Neither the retailers nor consumers know the quality of cheese. The bulletin contains 31 tables and 10 figures.   W.V.P.

165. Packaging American Cheese. WALTER V. PRICE, Univ. of Wisconsin, Madison. Wis. Agr. Exp. Sta. Research Bul. 130, Nov., 1935.

Fast-freezing of cured cheese in small packages seems to be a practical method of modernizing distribution of natural cheese. Cheese is selected and packaged at the most desirable stage of ripening. Quality and uniformity can, therefore, be identified by brand name. The package recommended is attractive, sanitary, and convenient for the consumer. Methods

of packaging, storing, defrosting, and merchandising are discussed in detail. The bulletin contains 9 tables, 11 figures and 39 illustrations.

W.V.P.

166. Observations on the Ripening of Cheeses Made from Raw and Pasteurized Milk. I. R. SHERWOOD, Dairy Research Inst. (N. Z.), Palmerston North, N. Z. J. Dairy Research *8*, p. 271, Sept., 1936.

The investigation was designed to show whether chemical changes produced in milk by pasteurization at various temperatures are sufficient to modify the proteolytic action of rennin, pepsin and trypsin on milk and on the cheese curd when bacterial action was inhibited by the addition of 2 per cent of chloroform.

To raw skimmilk and to skimmilk from the same bulk sample pasteurized for 30 minutes at temperatures of 100° F. to 212° F. were added 1.4 per cent rennet (factor sample), 0.6 per cent pepsin, 0.3 per cent and 0.1 per cent trypsin. The action of rennet and pepsin on the milk during 5 days at 20° C. was slightly reduced by heating the milk up to 140–160° F. while higher temperatures again increased proteolysis. In the case of the trypsin proteolysis during one day at 20° C. was markedly increased by increased heating temperatures up to 170° F. The change was especially marked over the temperature range of 150–160° F. By experiments, in which only the whey portion of the milk was heated and the milk then reconstituted, it was found that the change was due, not to an alteration of the casein, but to some change in the whey portion of the milk.

When cheese was made from raw milk and the same milk pasteurized at 165° F. and 175° F. it was found that the protein breakdown in the cheese proceeded more rapidly in the raw milk cheese than in the pasteurized milk cheese. The same was true when chloroform was added to the green cheese to destroy bacterial action. Thus it seems that the chemical change caused in the non-protein portion of the milk by heating reduces the proteolytic action of rennet and of bacteria on cheese curd. H.A.B.

167. Discoloration and Corrosion in Canned Cream. C. J. JACOBSON, G. R. HOWAT AND T. P. HOAR, The Hannah Dairy Research Inst., Kirkhill, Ayr, and the Metallurgical Laboratories, Univ. of Cambridge. J. Dairy Research *8*, p. 285, Sept., 1936.

Two defects in canned cream were studied, namely, bronzing or purpling of the can and pitting of the cream with large areas of discolored cream at the site of the pitting and loose black specks scattered throughout the cream. The purpling was found to be due to a film of tin sulphide and the black specks to ferrous sulphide, stannous oxide or both. Cysteine and methionine are considered the most probable forms of ''volatile'' sulphur in canned cream, being produced by the effect of heat with consequent denaturation of the proteins.

Purpling was produced by excessive time and temperature of sterilization, appearing in this experiment after 20 hours of storage in cream sterilized at 117–118° F. for 40 minutes, but not at 117–118° F. for 30 minutes, and not appearing after six weeks of storage when the cream was sterilized at 114–115° F. for 40 minutes. Addition of sodium bicarbonate up to 5 grams per gallon had, if anything, a slightly beneficial effect. Homogenization pressure appeared to have no definite influence on the subsequent attack of the can.

It is possible that sodium bicarbonate somewhat increases the production of the slight pitting of the can. Cans in which steel had been exposed by filing gave on processing a black film at the exposed steel and later black specks throughout the cream.

Large air spaces in a can did not enhance attack on the cans nor did a variation of pH of the cream within the limits studied appear to have any particular effect.   H A B.

Other abstracts of interest are numbers 168, 184, 188, and 189

CONCENTRATED AND DRY MILK

Abstracts of interest are numbers 156, 158, 168, 172, 175, 179, 181, 184, 188, 189, 191, and 194.

CHEMISTRY

168. The Acidity of Milk and Dairy Products. H. H. SOMMER, Univ of Wisconsin, Madison, Wis. Wis Agr Exp Sta Research Bul 127, Jan., 1935.

This bulletin is a discussion of existing knowledge of acidity in dairy products written for the benefit of dairymen and dairy technologists. It discusses the significance of pH; the acidity of freshly drawn milk; the constituents responsible for acidity of fresh milk; factors causing variations in acidity such as:—lactation, feed and mastitis; the acids formed by fermentation and the limitations of the acid test as a means of grading milk. There are careful discussions of the methods and significance of measurements of acidity in cream, condensed milk products and ice cream mixes. Scientific explanations are given for the value of pH measurements; effects of dilution of samples; and the fading of endpoint in titrations. A list of 27 references is given.   W.V.P.

169. Ultracentrifugal and Electrophoretic Studies on the Milk Proteins. I. Introduction and Preliminary Results with Fractions from Skimmilk. KAI OLUF PEDERSON, Inst. of Physical Chemistry, The University, Upsala, Sweden. Biochem. J. *30*, p. 948, 1936.

In this report the author has extended the work of Svedberg and his associates in characterization of the proteins of milk by use of increased centrifugal fields wherein the force is up to 260,000 times that of gravity. A description is given of a modified method for calculating sedimentation equilibrium concentration from the refractive index method.

The caseinogen is shown to be present in course polydisperse suspension. When the caseinogen was removed by ultracentrifuging, practically the whole whey protein was found to be present as molecules α, β and γ, when α is a low-molecular protein isolated by Kedwick (unpublished), β the lactoglobulin isolated by Palmer, and γ corresponds probably to what is generally called lactoglobulin.

The results of these experiments indicate that it makes little or no difference whether the caseinogen is removed by isoelectric precipitation or by ultracentrifuging. K.G.W.

170. **Ultracentrifugal and Electrophoretic Studies on the Milk Proteins. II. The Lactoglobulin of Palmer.** KAI OLUF PEDERSON, Inst. of Physical Chemistry, The University, Upsala, Sweden. Biochem. J. *30*, p. 961, 1936.

In this paper the author reports the results of an ultracentrifugal study on lactoglobulin prepared according to the procedure of Palmer of the Carlsberg Laboratory. The lactoglobulin prepared from cows' milk was found to be a monodisperse protein with a molecular weight of 39,000 and an isoelectric point of 5.19 in acetate buffers. The molecular weight appears to be independent of hydrogen ion concentration from very acid values (pH 1.0) to pH 9. Above pH 11.0 light absorption increases strongly and the sedimentation constant decreases, indicating profound changes in the molecule, probably hydrolysis. While the molecular weight was found constant between pH 1.0 and 9.0, a change in sedimentation constant between pH 7.5 is believed due to change of the molecular frictional constant. The latter may be due to either change in shape or kinetic volume of the particle, as for example, due to change in hydration. K.G.W.

171. **The Occurrence and Possible Significance of Some of the Minor Component Acids of Cow Milk Fat.** THOMAS PERCY HILDITCH AND HARRY PAUL, Dept. of Industrial Chemistry, Univ. of Liverpool, England. Biochem. J. *30*, p. 1905, 1936.

Previous studies concerning the composition of milk fat have been extended to ascertain the validity of quantitative data of the major component acids, and to ascertain whether any unsaturated acid of lower molecular weight than decenoic acid is present, and also to obtain evidence as to the position of the unsaturated group in tetra and hexadecenoic acids the presence of which was indicated by previous experiments.

By comparison of calculations of analyses of the fat with those obtained when the fat was hydrogenated the presence of lower unsaturated fatty acids was indicated.   In addition to decenoic and tetradecenoic acids, the presence of about 4–5 per cent hexadecenoic acids was determined.   When allowance for the lower unsaturated fatty acids is made, a correction for the major acids equal to an increase of 2 per cent for palmitic and a decrease of 5 per cent for oleic is necessary.   The positions of the double bond, relative to the carboxyl group are the same in the decenoic, tetra and hexadecenoic and oleic acids.   It is suggested that these observations are in harmony with the hypothesis, that lower saturated glycerides of milk fats have been produced from pre-formed oleo-glycerides and that minor lower unsaturated components may represent degradation produces of oleo-glycerides which have escaped complete saturation to lower saturated groups.   K.G.W.

FOOD VALUE

172. **The Nutritive Value of Raw and Pasteurized Milk for Calves.   The Assimilation and Retention of Nitrogen, Phosphorus and Calcium.**   JANET H. BLACKWOOD, SAMUEL MORRIS AND NORMAN C. WRIGHT, The Hannah Dairy Research Inst., Kirkhill, Ayr.   J. Dairy Research 8, p. 228, Sept., 1936.

Ten calves were fed during three 24-day-periods alternately on raw milk and milk pasteurized at 63–65° C. for 30 minutes and on another series three calves were fed raw milk and three pasteurized milk for 42 days.   All calves were fed on dam's milk for three days and then raw milk up to 10 days of age.

The two types of milk produced no significant differences in the percentage assimilation and retention of nitrogen, phosphorus and calcium. Retention values varied markedly between individual calves.   The mean retention values were highest for calcium, next highest for phosphorus and lowest for nitrogen.

It is concluded also that when milk is fed as a sole food for calves, it is relatively deficient in calcium and to a lesser extent in phosphorus.   A calf when fed, as in these experiments, on milk at the rate of 10 per cent of its live weight will be unable to obtain adequate calcium, if the daily gain in live weight exceeds $\frac{1}{3}$ kg.   With a live weight increase of $\frac{1}{2}$ kg per day, the phosphorus supplied will be inadequate and the calcium insufficient by over 40 per cent and with an increase in live weight of $\frac{3}{4}$ kg. per day, all three elements will be inadequate.   The milk used contained 0.45 per cent nitrogen, 0.09 per cent phosphorus and 0.10 per cent calcium.   The lack in calcium can be to some extent rectified by including pasture grass or hay in the ration.

H.A.B.

173. **Further Observations on the Effect of Dietary Caseinogen in the Prevention of Fatty Livers.**   ALAN WILMOT BEESTON, HAROLD

JOHN CHANNON, JOHN VAUGHAN LOACH AND HARRY WILKINSON, Dept. of Biochem., The University of Liverpool, England. Biochem. J. *30*, p. 1040, 1936.

Choline is known to have the property of preventing the accumulation, and accelerating the removal, of fat in the liver of the rat. It has been observed in experiments that the presence of protein in the diet had a similar effect and which is believed to act independently of contaminating traces of choline.

In continuance of these studies, the action of caseinogen has been equated against that of choline. One gram of caseinogen is equivalent in its preventative action on liver fat deposition to 7–8 mg. of choline. K.G.W.

174. Additional Observations on the Anemia Caused by Deaminized Casein. A. G. HOGAN, R. E. GUERRANT AND W. S. RITCHIE, Dept. of Agr. Chem., Univ. of Missouri, Columbia, Mo. J. Biol. Chem. *115*, p. 659, 1936.

Deaminized casein has been found to be inadequate as a nutritive protein source, and further, that it may cause anemia in animals when fed. The results of this paper show further data on the nature of the anemia producing property of the deaminized casein. The minimum amount of casein necessary to prevent anemia in experimental animals was 5 per cent of the ration; the minimum amount of deaminized casein required to produce anemia was found to be between 5 and 10 per cent of the ration. Lactalbumin of laboratory preparation does not prevent the type of anemia studied. Dried yeast 18 per cent confers protection against anemia caused by deaminized casein, while autoclaved casein or yeast does not. The active anemia producing agent was recovered in the sulfuric acid hydrolysate of deaminized casein, and in a similar manner, the anti-anemic agent was recovered from the hydrolysate of casein. K.G.W.

ICE CREAM

175. Escherichia-Aerobacter Group in Ice Cream. Proc. 36th Ann. Conv. Intern. Assoc. of Ice Cream Mfgrs. *2*, p. 7, Oct., 1936.

(A) Determination from a Laboratory Viewpoint. R. P. MYERS AND C. W. SORENSEN, Sealtest System Laboratories, Inc., Baltimore, Maryland.

In some laboratories considerable importance is attached to the presence in ice cream of organisms of the colon group. The test is occasionally used as a measure of the effectiveness of pasteurization. Since organisms within this group vary in thermal resistance and since pasteurization temperatures vary widely, it seemed desirable to establish the thermal resistance in ice cream for especially resistant strains of organisms within the colon group.

Two different strains of *E. coli* and one of *Aerobacter aerogenes* were selected for the study.

One strain of *E. coli* survived for a period of 20 minutes at 140° F. and for 5 minutes at 145° F.   The strain of *A. aerogenes* survived for 10 minutes at 140° F. and for 5 minutes at 145° F.   Neither organism would therefore survive pasteurization at 140° F. for 30 minutes.   However, the second strain of *E. coli* was much more heat resistant.   It survived for 118 minutes at 140° F., for 55 minutes at 145° F., for 24 minutes at 150° F., but for only 9 5 minutes at 155° F.   On the basis of these results a pasteurization temperature of 155° F. for 30 minutes is recommended to insure complete destruction of colon group bacteria in ice cream mix.

Aging ice cream mix at 45° F. for 24 hours had no appreciable effect on the thermal resistance of *E. coli*.

DISCUSSION, LED BY E. H. PARFITT, PURDUE UNIVERSITY, LAFAYETTE, IND

In studies at Purdue University, 67 cultures of *Escherichia coli* and *Aerobacter aerogenes* were selected and pasteurized in ice cream mix in capillary tubes.   No colon type organisms were found which survived 145° F. for 30 minutes.   Stark and Patterson, who isolated 505 pure cultures of Escherichia-Aerogenes organisms from water, also found that all the organisms isolated were destroyed at 145° F. for 30 minutes.

The paper of Myers and Sorensen shows clearly the need for uniform regulations as to time and temperature of pasteurization of ice cream mix. If the mix is pasteurized at 155° F. for 30 minutes and colon organisms are found in the finished product, a more accurate interpretation can now be placed upon these results than was possible previously.

B) Its Significance and Importance.   M. W. YALE, N. Y. State Agric. Exp. Sta., Geneva, N. Y.

The quality of bulk vanilla ice cream sold in Geneva was studied by the author.   Through line run tests the sources of contamination were determined for a number of ice creams.   The colon count proved to be a fairer measure of quality than the standard plate count since the freshly pasteurized mix in practically all cases was free from colon organisms.   Thus, the presence of colon organisms is primarily an index to handling of the product subsequent to pasteurization.   Discriminating manufacturers should include tests for colon organisms in finished products since their presence is always undesirable and indicative of some faulty condition.

Relatively high colon counts in the case of ice cream with low standard plate counts are significant and line run samples will usually show contamination either from ingredients or from equipment.

The colon plate count is more sensitive in detecting contamination from the vendor's dipper than is the standard plate count.

Since there are instances where total counts indicate faulty conditions but colon counts do not, a test for the colon group should supplement rather than supplant the standard plate count.

DISCUSSION BY A. C. FAY, KANSAS AGRIC. EXP. STA., MANHATTAN, KANSAS

The colon count has some value as an index to pasteurization especially if high temperatures are employed. If the usual thermal exposure of 145° F. for 30 minutes is employed the interpretation of the test must be made with caution. The test has some value as an index to the contamination of ice cream subsequent to pasteurization, especially if the freshly pasteurized product is known to be free from colon types.

The colon test serves as an index to the general sanitary conditions surrounding the production of ice cream, but in this capacity is a poor substitute for the total count. Since the standards of interpretation for colon counts are much lower than for total counts, the method affords an excellent means of demonstrating contamination of small magnitude such as from the vendor's dipper. Its value in this connection depends on the assumption that the contamination involves organisms of the Escherichia-Aerobacter group.

These limitations of the colon count are pointed out so as to enhance its value by avoiding the pitfalls of misinterpretation. Since any method of analysis has its limitations, intelligent interpretation of the results secured is essential if the greatest good is to result.

(C) At the Fountain. F. W. FABIAN AND A. E. HOOK, Michigan State College, East Lansing, Mich.

A sanitary survey was made of the 96 places in Lansing and East Lansing serving ice cream to the public. A bacteriological study was made of the water found in the receptacles holding the ice cream dippers. One city has a ruling that the dippers be kept in running water between servings while the other city has no such requirement.

At fountains where the dippers were kept in running water, the total bacterial count as well as the Escherichia-Aerobacter count of the water was less than where still water was used. Eighty-one per cent of the samples of still water had a plate count in excess of 100,000 bacteria per cc. while only 18 per cent of the samples of running water exceeded 100,000 bacteria per cc. Ten of the 18 per cent of samples of running water which exceeded 100,000 cc. were probably high because the water was running too slowly through the receptacle containing the dippers.

There is a general relationship between the total bacterial count and the Escherichia-Aerobacter content of retail ice cream when the count exceeds 100,000 bacteria per cc. Below this, the relationship is less marked. However, there seems to be no direct correlation between the Escherichia-Aerobacter content of the ice cream being served and the dipper water.

A correlation was observed between the general sanitation of the retail establishment and the bacterial content of the dipper water. Restaurants have a higher sanitary rating than pharmacies when the basis of comparison is the bacterial content of the dipper water.   M.J.M.

176. The Relation of Fruit, Flavors, Nuts and Colors to the Sanitary Production of Ice Cream. Proc. 36th Ann. Conv. Intern. Assoc. of Ice Cream Mfgrs. *2*, p. 40, Oct., 1936.

(A) Importance of Problem from Public Health Point of View.
M. J. PRUCHA, University of Illinois, Urbana, Illinois.

In the bacteriological examination of fruits, nuts, flavors and colors, extremely high bacterial counts were found in several dye solutions. Frozen fruits, flavors, nut meats and candy frequently contain several thousand bacteria per gram. Molds and yeasts are present in many samples of frozen fruits, color solutions and nut meats. *Escherichia coli* were found in some color solutions, candy and nut meats but not in frozen fruits or flavor extracts. However, there is no definite evidence that these materials had infected ice cream with disease bacteria and that such ice cream caused epidemics. '

The proper inspection and control by health officers of plant operations where fruits, nuts, colors and flavors are manufactured and handled is recommended. It is also suggested that the ice cream manufacturer take proper care of these ingredients by the following methods:
1. Keep the ingredients under proper sanitary conditions.
2. Treat the ingredients so as to keep them safe.
3. Purchase only good products from companies exercising sanitary precautions.
4. Carefully pasteurize the mix and guard against recontamination of the product after pasteurization.

(B) Importance of Problem from Ice Cream Manufacturer's Point of View. H. F. DEPEW, Luick Ice Cream Co., Milwaukee, Wis.

Contamination by workers of flavoring materials and colors should be avoided so far as possible, particularly with fruits and nuts which are not pasteurized.

The recommendation is made that color solutions be made in quantities of about a week's supply and that they be kept refrigerated. The pasteurization of color solutions is recommended. Pasteurization of colors does not result in off-shades or fading of the color. The use of preservatives in color solution is not recommended.

Nut meats should be kept in a dry, cold storage at about 32° F. The purchase of fumigated nuts is probably desirable. All choppers, slicers, and other equipment coming in contact with nuts should be carefully cleaned and sterilized before use.

The opinion is expressed that the pasteurization of all fruits used in ice cream is inadvisable. A cooked or preserved flavor was evident in the resultant ice cream and the fine, fresh, clean fruit flavor was lost when the fruit was pasteurized. Fruit purchased from reputable packers was found to be reasonably low in bacterial content. Fruit should be stored at temperatures near 0° F. and should be thawed in a room having a temperature between 32 and 40° F. Only fruit for immediate use should be thawed.

Flavors and syrups should be pasteurized when practical. Only the best quality of raw materials should be used in their manufacture and all utensils and containers should be cleaned and sterilized before use.

Since specific sanitary procedures have not been developed for handling fruits, nuts, flavors and colors, the industry is urged to study the problem so as to learn the practicability of various proposals as well as future proposed legislation along this line. M.J.M.

177. A Study of Methods Used to Improve the Sanitary Quality of Nut Meats, Flavoring and Coloring Used in Ice Cream. P. H. TRACY AND W. H. BROWN, Univ. of Ill., Urbana, Ill. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. 2, p. 52, Oct., 1936.

Different methods of soaking nuts previous to shelling were studied and were found to increase the moisture content of the resultant nut meats. The soaking process injured the texture of the nuts.

Since nut meats often show evidence of human contamination, methods were studied for improving the sanitary quality of nuts. The best treatment studied was to dip the nuts into hot (180° F.) sucrose solution for 30 to 60 seconds, then dry for 2.5 minutes in a 250° F. oven. The nuts should then be kept in cold storage, preferably in Glassine bags, until used. Nuts treated in this way contained less than 100 bacteria per gram and were free from *Escherichia coli.*

Heating frozen pack strawberries previous to use is recommended as a means of lowering the bacterial content of this ingredient. Pasteurization of the berries at 145° F. for 30 minutes was practically as efficient as higher temperatures and the flavor was injured but slightly at the low temperature.

Experiments with flavoring extracts pasteurized at 145° F. for 30 minutes indicate that, in case there is doubt as to the sanitary quality of the extract, heating can be resorted to without decreasing the value of the flavor for ice cream. The trials indicate that vanilla extract subjected to this treatment can be used satisfactorily.

Pasteurization of color solutions proved successful. There was no injury to the quality of the color providing the temperature did not exceed 145° F.–160° F. M.J.M.

178. Frozen Cream—The Best Method of Handling and Use. R. R. GOCKLEY, Dairymen's League Cooperative Association, New York,

N. Y. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *2*,
p. 68, Oct., 1936.

Since ice cream made entirely from frozen cream has a different flavor
than that made from fresh cream, the use of frozen cream for more than 60
per cent of the butterfat is not recommended.

Frozen cream can be satisfactorily melted (1) by storing over night at
room temperature until it is sufficiently melted to permit dumping from the
cans or (2) by setting the cans in a tank of water controlled to a definite
temperature. The average melting time by either method does not permit
increases of significance in bacterial content of the cream. Some companies
have utilized an ice crusher to crush the frozen cream. The maintenance of
sanitary conditions is difficult with this method.

Clean flavored frozen cream has been reconstituted and sold as fluid cream
without objections from the buyer.   M.J.M.

179. **Cooperation between Accounting and Production Departments for
    Increased Plant Efficiency.** L. C. ANDERSON, General Ice Cream
    Corp., Schenectady, N. Y. Proc. 36th Ann. Conv. Intern. Assoc.
    Ice Cream Mfgrs. *2*, p. 70, Oct., 1936.

The accounting department should equip the production department with
adequate inventory and factory record forms so that complete information
as to mix making costs, freezing costs, etc., are properly arrived at. Coopera-
tion between accountant and production man is necessary to produce reliable
cost figures and the use of these data by the production man will aid in
increased plant efficiency.   M.J.M.

180. **Sales Potentialities of Ice Cream.** AUBYN CHINN, National Dairy
    Council, Chicago, Ill. Proc. 36th Ann. Conv. Intern. Assoc. Ice
    Cream Mfgrs. *1*, p. 73, Oct., 1936.   ·

The use of ice cream twice a week in the home is suggested as a modest
goal for which to strive. This offers a potential increase of 300 per cent in
the use of ice cream over present consumption. The present popularity of
ice cream outside the home indicates that the success of any program for
increased sales is limited only by the effort with which the program is car-
ried out.

The following suggestions are offered as methods for placing ice cream
consumption on a permanently higher plane.

1. Place before the professional leaders in the medical and educational
   fields, the quality and superior food value of commercial ice cream.
2. Integrate projects and material on ice cream in the regular educational
   program in schools.
3. Increase consumer knowledge of the composition, and the manufacture
   of commercial ice cream using all publicity and educational channels,
   such as newspaper editorials, leaflets for direct mail to consumers and
   food demonstrations.

4. Stimulate increased use of ice cream for young adults in factories and offices for between-meal pick-up through appeals to beauty, weight control and physical finess. M.J.M.

181. Production Planning in Relation to Personnel. RIDGWAY KENNEDY, JR., Abbotts Dairies, Inc., Philadelphia, Pa. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *2*, p. 78, Oct., 1936.

The accountant should supply the production department with production schedules for the same month of previous years. The figures should be divided into the various units as bulk, package, brick, cups, novelties, etc. The production department should know the amounts of each product which can be turned out for each shift. From these figures the number of workers necessary can be ascertained.

Different departments of the business do not have peak loads at the same time. Therefore trained workers should be retained whenever possible and merely shifted from one department to another. Extra help should be employed prior to the peak load so that they will be familiar with the work by the time that maximum production must be obtained . M.J.M.

182. Organization and Operation of a Cabinet Service Department. O. F. BOYER, Ice Cream Refrigeration Service Co., Los Angeles, Calif. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *2*, p. 81, Oct., 1936.

Service department costs are entirely dependent upon the make, age and condition of refrigeration equipment as well as the amount of the dealer's equipment which the sales department agrees to refrigerate. Multiple hookups on a single compressor usually cause trouble. The nearer one stays to one cabinet on one compressor, the cheaper will be the refrigeration costs.

All cabinets should be inspected regularly at intervals of about four times yearly. Large cabinets are no more costly to service than small ones. A fair average cost per compressor, per month, for maintenance is about $1.50.

M.J.M.

183. Economical Layouts for the Manufacture of Novelties. JOHN W. BURDAN, Philadelphia Dairy Products Co., Philadelphia, Pa. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *2*, p. 87, Oct., 1936.

A description is given of a satisfactory layout for making Popsickles, Fudgicles, etc.

The author suggests that in planning a novelty department first consideration be given to the question of sanitation since these operations can easily become insanitary. Such problems as the economical handling of materials to prevent waste, increased efficiency of labor, refrigeration, etc., should be decided only along lines which will not conflict with sanitary arrangements.

M.J.M.

184. The New Developments at the Dairy Industries Exposition. BYRON
MORRIS, Perry Creamery Co, Tuscaloosa, Alabama   Proc 36th
Ann Conv Intern Assoc Ice Cream Mfgrs *2*, p 92, Oct , 1936

In this paper and the lengthy discussion following it, which also is
recorded in the proceedings, many of the outstanding developments in
machinery and methods which were shown at the 1936 Dairy Industries
Exposition are discussed   M J M

185. Flooded and Refrigerant Control System. FRED APHULS, Consult-
ing Engineer, New York, N Y   Ice and Refrig *91*, 2, p 146, Aug ,
1936

The author points out that the flooded system makes more effective use
of the cooling system, permits smaller mean temperature differences and
facilitates efficient operation   It is pointed out that for efficient operation,
the temperature of the vapor entering the refrigerating machine should be
kept 10° F. higher than the boiling point of the liquid at the indicated suc-
tion pressure   Five methods for regulating the liquid flow to the refrigera-
tion machine are briefly described and evaluated   A liquid separator located
above the cooler may be used together with a liquid return line to the bottom
of the cooler   A pump may be used for returning unevaporated liquid to the
bottom of the cooler   A low pressure float valve may be used   A liquid trap
in the suction main with a return pipe to the bottom of the cooler may likewise
be used   Suction stop valves, thermostatically controlled may also be used
Emphasis is placed upon designating a system which gives the operator an
opportunity to see what is going on   L C T

186. Frozen Desserts. P H TRACY. Ill. Agr. Exp Sta Cir 462, Nov ,
1936

"Nutritious, attractive, inexpensive, and convenient to serve, ice cream
deserves the great popularity it has in the American menu."   This circular
discusses the ingredients of ice cream and describes the preparation of ice
cream mixes for use in the home

Various types of freezers and their use in the home are described

Many recipes for home-made ice creams, ices and sherbets are given and
also directions for preparing fancy deserts.   O R.O.

187. Ice Cream Sales Index.   The 41st Production and Distribution Sur-
vey of the Statistical and Accounting Bureau, Intern. Assoc. of Ice
Cream Mfgrs , Washington, D C.

This survey of ice cream sales in the United States for the first nine
months of the year 1936, when compared with the same months of the year
1935, shows an increase of 20 64 per cent in sales of ice cream.   The increase
in sales for the same period in the Dominion of Canada was 9 82 per cent.

The effect of the Kentucky sales tax of 28 cents per gallon for ice cream, which went into effect on July 1, 1936, is shown graphically in this survey. During the month of June (the last month before the tax became effective) sales of ice cream in Kentucky increased 59.39 per cent over the like month of the previous year. During the months of July and August (with the tax in force) ice cream sales decreased 14.17 and 15.43 per cent, respectively, when compared with the same months in 1935. In the states adjacent to Kentucky, increases in sales of 33.11 and 23.86 per cent, respectively, occurred in these same months.   M.J.M.

Other abstracts of interest are numbers 157, 159, 161, 163, 168, 172, 188, 189, 191, and 194.

MILK

188. The Comparative Values of the Plate Count and the Modified Methylene Blue Reduction Test as Routine Methods for Grading Milk. A. A. NICHOLS AND S. J. EDWARDS, The Hannah Dairy Research Inst., Kirkhill, Ayr. J. Dairy Research 8, p. 258, Sept., 1936.

In a large number of comparisons it was found that a remarkably high correlation exists between the results of the plate count and the methylene blue reduction test. Correlation coefficients were calculated by the extended method. Regression equations were determined to express one variable in terms of another. Plate counts were expressed as logarithmic values.

Both the plate count and the reduction test also show a fairly high correlation with the keeping quality and with the presumptive coliform test. The correlations with the laboratory post-pasteurization counts are only moderate.

Correlations between farm inspection scores and plate count or reduction test were of a low order. The farm score card allowed 150 points for methods of production and 50 points for equipment. A good correlation, however, was noted between the tests and the storage temperature of the milk. The storage temperature affects the reduction test to a greater degre than the plate count indicating that the reduction test is more sensitive to growth of bacteria than the plate count. For every increase of 4° F. in the temperature of storage there was on the average a decrease in reduction time equivalent to 70 minutes and an increase in the plate count of roughly 150 per cent.

A high count in mixed milk of the B haemolytic variety of *Streptococcus agalactiae,* most commonly responsible for mastitis in cows, was found to be associated with a high total plate count and a short reduction time. The presence in mixed milk of milk infected with streptococcal mastitis did, therefore, not invalidate the methylene blue reduction test.

It is concluded that the reduction test, although it involves an inherent error of about 17 per cent due to the half hour periods between readings, is

likely to give more consistent and more easily duplicated results than the plate count.   H.A.B.

189. The National Dairy Council. Miss AUBYN CHINN, National Dairy Council, Chicago, Ill.   Milk Dealer *26*, p 30, Dec., 1936.

A complete description of the eight-point program of the National Dairy Council.   The author also gives details as to how the council functions and a summary of what the council did last year.   C.J.B.

190. Certified Milk—The Oldest Graded Milk in the World. HARRIS MOAK, Milk Comm., Kings Co. Medical Society, Brooklyn, N. Y. Milk Dealer *26,* p. 42, Dec., 1936

The author presents a brief history of Certified Milk.

C.J.B.

191. Recent Work of the Public Health Service on Milk Pasteurization. LESLIE C. FRANK, Office of Milk Investigations, U. S. Public Health Service, Washington, D. C.   Milk Dealer *26*, p. 48, Dec , 1936.

A summary of the milk sanitation work of the U. S. Public Health Service.

.   C.J B

192. A Quarter of Century in Retrospect. H. H. SOMMER, University of Wisconsin, Madison, Wis. .   Milk Dealer *26*, p. 60, Dec., 1936.

The author reviews the progress of the fluid milk industry during the past 25 years.   The review covers new and improved types of equipment, methods of processing, enactment of ordinances, nutrition, etc.

C.J.B.

193. The Milk Marketing Program of the American Jersey Cattle Club. JAMES D. BREW, American Jersey Cattle Club, New York.   Milk Dealer *26*, p. 68, Dec., 1936.

The author briefly outlines the program of the American Jersey Cattle Club for the marketing of "Jersey Creamline Products."   C.J.B.

194. New Developments in the Field of Vitamin D Milk. W. E. KRAUSS AND R. M. BETHKE, Ohio Agr. Exp. Sta., Wooster, Ohio.   Ohio Agr. Exp. Sta. Bi-monthly Bul. *22*, p. 3, Jan.–Feb., 1937.

This is a revision of a previous article (Ohio Agr. Exp. Sta. Bi-monthly Bul. 20, March–April, 1935) and brings up to date the status of vitamin D milks.   Details of the various methods used to fortify milk with vitamin D are given, methods of control are discussed, clinical evidence on the value of vitamin D milks is brought up to date, data on the present output are given, and suggestions are made for maintaining a proper perspective in developing this phase of the dairy industry.   W.E.K.

195. Legume Silage for Dairy Cows. C. C. HAYDEN, A. E. PERKINS, W. E. KRAUSS, C. F. MONROE AND R. G. WASHBURN. Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Agr. Exp. Sta. Bi-monthly Bul. 22, p. 21, Jan.–Feb., 1937.

Three systems of ensiling legumes are discussed: (1) no treatment other than a brief drying period in the field; (2) addition of feeding molasses; (3) addition of mineral acids (A. I. V. system). Of these, the mineral acid method has received particular attention and has given uniformly best results with respect to carotene preservation.

Data presented show that the feeding of large quantities of A. I. V. silage over a period of five months exerted no detrimental effect on the cows. although ammonia in the urine markedly increased and bicarbonates markedly decreased. The CO_2 capacity of the blood serum was practically unchanged.

In a reversal feeding trial no difference was found between the production value of A. I. V. silage and alfalfa hay when fed on approximately the same dry matter basis.

Carotene was preserved to a high degree in the A. I. V. silage. This resulted in maintaining a high carotene content in the butterfat of both Holsteins and Jerseys throughout the winter when silage was the only roughage fed. In the reversal feeding trial the cows produced butterfat of much higher carotene content when receiving A. I. V. silage and corn silage than when receiving alfalfa hay and corn silage of equivalent dry matter content.

The question, "Is there a Place for Legume Silage?" is discussed with an affirmative trend.   W.E K.

196. Sampling Is Aid in Locating Milk Troubles. C F. MONROE, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Agr. Exp. Weekly Press Bul. 22, p. 47, Jan.–Feb., 1937.

In order to help locate the source of off-flavor or other abnormalities in milk it is suggested that samples be drawn from individual cows into sterile containers. After allowing to stand at room temperature for several hours, examination for off-flavor and physical defects will either establish the cow as the offender or suggest that the trouble lies somewhere in the process of handling the milk after it leaves the cow.   W.E.K.

197. Are Your Sales Receipts Up to Delivery Costs? WAYNE DINSMORE, Secretary, Horse and Mule Association of America. Milk Dealer 26, p. 66, Dec., 1936.

The single horse and wagon is the milkman's ideal delivery unit because it delivers milk for an average of less than 5 per cent of sales anywhere, East, West or South. The average motor truck route cost of sales ranges from 7 per cent to 10 per cent of sales. No single horse route at present

should exceed $50 per month in total cost—horse, wagon, harness and stable overhead, all included.   The average, companies from 29 states included, is $46.86.   The average motor truck cost from companies in the same 29 states is $80.78.   The average horse route sells more milk than the average motor truck route.   The horse is the business getter, the salesman's helper, who handles the wagon while the salesman takes care of the milk.

The author presents cost figures to substantiate the above statements.

C.J.B.

Other abstracts of interest are numbers 156, 158, 168, 172, 175, 178, 179, 181, 184, and 185.

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

CONTENTS

PUBLICATIONS AND ABSTRACTORS

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

198. A Comparison of Ten Presumptive Test Media Used in the Detection of the Escherichia-Aerobacter Group in Milk. MICHAEL A. FARRELL, Division of Bacteriology, Penn. State College, State College, Pa. JOURNAL OF DAIRY SCIENCE *20*, 2, p. 67, Feb., 1937.

Brilliant green lactose bile broth, fuchsin lactose broth and methylene blue-brom cresol purple broth were found to be the most efficient of the presumptive media for the detection of Escherichia-Aerobacter. The question was raised whether we possess a reliable medium for the detection of these organisms. J.C.H.

199. Variants of Streptococcus Lactis Which Do not Ferment Lactose. E. S. YAWGER, JR., AND J. M. SHERMAN, Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *20*, 2, p. 83, Feb., 1937.

Four cultures of *Streptococcus lactis,* which did not ferment lactose, but were typical in all other respects, were isolated from milk. It is believed that these cultures are naturally occurring variants since one strain after cultivation in milk for ten months, is gradually acquiring the ability to ferment lactose. J.C.II.

200. Fermentative Variability Among Substrains of Streptococcus Cremoris and Streptococcus Lactis Obtained from Pure Cultures. J. H. SHERMAN AND R. V. HUSSONG, Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *20*, 2, p. 101, Feb., 1937.

It is doubtful if a differentiation can be founded on the fermentation tests between *S. cremoris* and *S. lactis.* The authors are inclined strongly to believe that *S. cremoris* is a distinct species, and work now in progress leads them to hope that it will be possible, for the first time, to define this organism clearly. J.C.H.

201. The Detection and Significance of Escherichia-Aerobacter in Milk. III. Correlation of Total Bacterial Count and Presence of the Coli-Aerogenes Group. M. T. BARTRAM AND L. A. BLACK, Dept. of Bacteriology, Univ. of Maryland, College Park, Md. JOURNAL OF DAIRY SCIENCE *20*, 2, p. 105, Feb., 1937.

These and other results indicate that an accurate test for colon-aerogenes organisms in pasteurized and in certified milk would be a valuable aid in the determination of the sanitary quality of the milk. J.C.H.

202. Streptococcus Durans n. sp. JAMES M. SHERMAN AND HELEN UPTON WING, Cornell Univ.,Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *20*, 3, p. 165, March, 1937.

A more complete description and a new name, *Streptococcus durans* n. sp., was given for a bacterium previously described by the authors.   A.C.D.

203. The Reliability of Selected Tests for the Detection of Mastitis. A. O. SHAW, H. C. HANSEN, AND RICHARD C. NUTTING, Idaho Agr. Exp. Sta., Moscow, Idaho. JOURNAL OF DAIRY SCIENCE *20*, 4, p. 199, April, 1937.

The milk of cows known to be free from mastitis or to be afflicted in varying degrees was tested to determine the accuracy of the following methods of detecting mastitis, namely the presence of mastitis and hemolytic streptococci, cell count, chloride content, and hydrogen ion concentration.

A.C.D.

204. Streptococcus Cremoris. E. S. YAWGER, JR., AND J. M. SHERMAN, Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *20*, 4, p. 205, April, 1937.

An extended description of *Streptococcus cremoris* is given with special emphasis to those characteristics by which it may be distinguished from *Streptococcus lactis*.   A.C.D.

205. Discussion of the Escherichia coli Test to Determine the Efficiency of Pasteurization. A. R. MacLEAN, Eastern Dairies, Ltd., Montreal, P. Que. Proc. 29th Ann. Conv. Intern. Assoc. of Milk Dealers, Lab. Section, p. 3, 1936.

During a period of eighteen months in 1935 and 1936 using the Brilliant Green Bile (Difco 2 per cent) method as a presumptive test for *Escherichia coli* tests were made upon daily samples taken from normal plant operation. The average of 7,460 tests of 1 cc. milk samples and 2,666 tests of 10 cc. samples showed 99.6 per cent and 96.6 per cent, respectively, as negative. The average of the corresponding highest prevailing average plate counts was 9,470. The use of 1 cc. samples in duplicate and a single 10 cc. sample of pasteurized milk is recommended as a satisfactory modified technic for plant control. The author's experience has been that when the three tubes constituting this technic are all negative the plate count of the sample is almost invariably below 10,000 colonies per cc. The author suggests that his technic might be used as a means of reducing the number of plate counts and yet obtain a more satisfactory insight into the degree of plant sanitation.

E.F.G.

206. Motion Pictures Showing the Growth of Bacteria (Escherichia coli) from a Single Cell. MORTON C. KAHN, Cornell Univ., Med.

College, New York City. Proc. 29th Ann. Conv. Intern. Assoc.
Milk Dealers, Lab. Section, p. 9, 1936.

The value of the moving picture film for the study of the reproduction
activities of bacteria is outlined. A reel of film depicting bacterial growth
was shown at the session. E.F.G.

**207. Proposed Changes in Standard Methods, Medium and Temperature
of Incubation.** A. J. POWERS, Chairman, Standard Methods Com-
mittee 1. A. M. D. Proc. 29th Ann. Conv. Intern. Assoc. Milk
Dealers, Lab. Section, p. 38, 1936.

The proposal to change the standard nutrient agar to tryptone-glucose-
skimmilk agar and lower the incubation temperature from 37° to 32° C.
seemed to warrant a thorough comparison of the two methods by many dif-
ferent laboratories. Seventeen laboratories in 10 states cooperated in mak-
ing some 25,150 individual plate counts covering a period of 12 weeks com-
mencing about the week of May 12, 1936, on raw, Grade A pasteurized, Grade
B pasteurized and cream pasteurized.

The procedure followed is given. The results are reported by the col-
laborator, Mr. Ernest Kelly. E.F.G.

**208. Report of Collaborator on Cooperative Work with Proposed
Changes in Medium and Temperature of Incubation.** ERNEST
KELLY, U. S. Dept. of Agr., Washington, D. C. Proc. 29th Ann.
Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 50, 1936.

A statistical analysis of 25,150 counts by means of standard agar and
tryptone-glucose skim milk agar both at 37° C. and 32° C. is presented.
These counts were obtained by 17 different laboratories according to a pro-
cedure specified by the Standard Methods Committee I. A. M. D. The fol-
lowing is a partial summary of the extensive tables presented by Mr. Kelly.

Raw milk with standard agar gave higher counts in 82 per cent of the
samples with an average increase of 44 per cent in count with plates held 48
hours at 32° C. compared with 37° C. Eighteen per cent of the samples
showed a decrease averaging 23 per cent. The net result on all 1,146 samples
was an increase of 37 per cent in count at 32° C. over 37° C.

Grade A pasteurized under the same conditions gave increases in 87 per
cent of the cases with average increase of 156 per cent and a net increase on
all samples of 72 per cent.

Raw milk samples, when plated on tryptone agar and incubated at 37° C.,
gave higher counts in 68 per cent of the samples with an average increase
of 74 per cent as compared with standard agar. The 32 per cent of the
samples which showed a decrease for tryptone agar decreased 84 per cent
leaving a net decrease with 1,157 samples of 7 per cent for tryptone agar at
37° C.

Grade A pasteurized milk under these conditions gave an increase in 70 per cent of the cases with an average increase in count of 91 per cent and a net increase for all samples of 46 per cent.

Raw milk samples with standard agar at 37° C. compared with tryptone agar at 32° in 87 per cent of samples gave an average increase of 68 per cent with the latter. Thirteen per cent of the sample decreased 40 per cent with tryptone agar leaving a net increase for 1,142 samples with tryptone agar at 32° C. of 59 per cent.

Grade A pasteurized milk gave an increase with tryptone agar at 32° C. compared with standard agar at 37° C. in 89 per cent of the instances with an average percentage increase in count of 237 and a net increase in 1,051 samples of 120 per cent.

Results of the same general trend are given for Grade B pasteurized milk and pasteurized cream with the greatest increase for the new technic in the case of pasteurized cream. Greater percentage increases were also generally obtained in milk and cream with the lower counts.

The increase due to the substitution of tryptone agar for standard agar at 37° C. was the least potent factor tried, but results in a fairly uniform increase of about 50 per cent in all products.

Lowering the temperature of incubation from 37° C. was the greatest single factor in increasing counts irrespective of the culture media used.

A combination of tryptone agar medium and incubation at 32° C. had the greatest effect in increasing the count of all products examined.

E.F.G.

209. Comments on Possible Influence of Variations in Laboratory Technic. J. F. CONE, U. S. Dept. of Agr., Washington, D. C. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 75, 1936.

Referring to the tabulations of results of comparison of standard plate method and tryptone agar at 37° C. and 32° C. by 17 laboratories under the direction of Standard Methods Committee the variations in incubator temperature, agar temperature at pouring, pH of media and colonies per plate were discussed.   E.F.G.

210. Differential Value of a Milk Medium Containing at Least Two Per Cent of Skimmilk. C. N. STARK, Cornell Univ., Ithaca, N. Y. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 82, 1936.

The addition of 2 per cent skimmilk to agar has given 2 to 4 times as high a count as was obtained on standard agar and the colonies were larger and easier to count. The presence of lactic acid producing bacteria and casein digesting bacteria could also be detected without the expense of using an additional medium. The addition of skimmilk should be given consideration when changing the standard medium.   E.F.G.

211. Sources of Milk Solids for Use in Modified Media. ALEC BRAD-
FIELD, Vermont Agr. Exp. Sta., Burlington. Proc. 29th Ann.
Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 94, 1936.

Examination of 665 samples of raw milk with tryptone-glucose skimmilk
agar suggested by Bowers and Hucker and incubated at 32° C. showed a
higher count in 88 per cent of the cases than when plated on standard nutrient
agar and incubated at 37° C. In pasteurized milk increased counts occurred
in 94 per cent of the instances. Udder flora did not develop appreciably
larger numbers of colonies.

No significant difference in numbers of colonies developing on plates were
found when using fresh skimmilk, milk flakes or spray powder at the rate
of 0.5 per cent calculated as liquid milk in the above modified media although
vacuum drum and roller methods gave less satisfactory results because of
more variation Adding reconstituted milk or dry milk solids were equally
satisfactory and fresh skimmilk appeared to have no advantage.

E.F.G.

212. Coli Bacilli and Coliphages in Infants. ERENE LIPSKA. Biochem-
ical Laboratory, School of Hygiene, Warsaw, Poland. Le Lait
16, 153, March, 1936.

The coli bacilli isolated from the excrement of 42 infants exhibited bio-
chemical properties intermediate between those originating from feces and
those originating from milk. Coli bacilli from the excrement of well and
sick infants were alike in their biochemical reactions. The filtrates from
excrement of infants were less active for bacilli of the colon typhoid group
and for dysentery bacteria than were filtrates of milk. The filtrates from
excrement from sick infants were less active for the bacteria studied than
were those from well infants. The activity of the filtrates studied extended
at the most to 10 stocks. The more active bacteriophages formed on gelose
slants in areas of 1 to 2 millimeters in diameter. The various biochemical
reactions studied were the following: glycerol, sorbitol, dulcital, raffinose,
sucrose, salicin, fluorescence of neutral red, coagulated milk, hydrogen sul-
phide, indole, Voges-Proskauer, sodium citrate, and sodium propionate.

A.H.J.

213. On the Probability of Pure Culture Isolation fro a Petri Plate. T.
MATUSZEWSKI AND J. SUPINSKA, Inst. F. Gärungsgewerbe u. landw.
Bakt. b. Museum f. Gew. u. Landw., Warschau and J. Neyman,
Abtlg. f. angew. Statistik d. Univers. London. Zentr. Bact. II,
95, p. 45, 1936.

The authors tried to determine how great is the probability that a single
colony picked out from an agar plate is really derived from a single cell.
The mathematical methods used were the formulas of Poisons law and the
tables of Elderton. It could be shown that the values depend (1) on the

size of the colonies, (2) on the number of colonies, (3) on the size of the plate. A table is given to show the probability of securing a colony derived from a single cell, if there are different initial conditions. A further table gives corrections to determine from these values the real number of originally suspended individual bacteria per colony.   K.J.D.

214. Foul, Stringy Milk. O. LAXA, Prag. Zentr. Bact. II, *95*, p. 125, 1936.

The author explains a special ropy fermentation where not only the consistency but also the flavor of milk has been materially affected. The milk was very stringy, soured slowly and afterwards acquired a bad smell, which later resembled trimethylamine. The cream separated as a foamy layer on the milk. The causative organism was named *Viscobacterium lactis foetidum* (1.5 μ long and 1 μ broad, with distinct capsules). Its cultural and physiological characteristics are given. Besides the above mentioned properties it may be emphasized that CO_2 is developed from lactose and that the slime is formed from proteins or amines and not from carbohydrates.   K.J.D.

215. Studies on Bacterium Herbicola. E. MACK, Milchw. Forschungsanstalt in Kiel. Zentr. Bact. II, *95*, p. 218, 1936.

An extensive study was made of numerous strains of *Bacterium herbicola*. They could be secured regularly from small fleshy plants, less regularly from trees and bushes. All strains showed identical characteristics, morphologically, and physiologically. There is no kinship to Bergey's *Flavobacteria* except *Flavobacterium trifolii*. The latter is named by the author "*Flavobacterium herbicola*, Burri et Düggeli." It could not be shown that there is any life cycle relationship between *Bact. herbicola* and Coli-organisms or between *Bact. herbicola* and *Streptococcus lactis* as Hüttig tried to demonstrate some time ago. The behavior in milk is the following: Only a few strains are able to ferment lactose (weak acid and strong slime formation). Generally milk remains unchanged a long time except for the formation of a tough yellow skin on the surface. There is no visible protein decomposition, the milk, however, acquires a bitter taste after a few days. At higher temperature milk is curdled by rennet formation. The determination of Amino-N (after Van Slyke) revealed a weak protein decomposition. There is no fat hydrolyzation. All strains are killed by holding pasteurization. At room temperature *Strept. lactis* is a strong antagonist of *Bact. herbicola*, but not at refrigerator temperature.   K.J.D.

216. Transformation of Streptococcus lactis (lacticus, acidi lactici) into Streptococcus faecium (faecalis, Enterococcus). W. STORCH, Milchw. Forschungsanstalt in Kiel. Zentr. Bact. II, *95*, p. 284–310, 1936.

These experiments were performed to show if there is any closer relationship between the *Streptococcus lactis* and *Streptococcus faecium*, since this

is the opinion of some authors of former and recent years (Kruse, Ayers and Johnson, Gundel, Demeter). The method used to show this was to treat typical *S. lactis* strains culturally in such a way that they might acquire the characteristics of *S. faecium*. The transformation experiments by passages in milk, peptone-milk, mash and peptone-mash + rye-decoct were only partially successful, since the transformations did not prove to be constant. A further passage in alkalinized mash + oxgall did not improve the constancy of the transformation. Good results, however, were achieved by heating the *S. lactis* strains twice to 63° C. for 15 minutes. Treating *S. lactis* strains analogous to the conditions in the human alimentary tract also gave positive results under certain conditions. It looks as if the enzymes promote the transformation ability of *S. lactis* into *S. faecium*.　　　　　　　　　K.J.D.

217. On Relations Between Pork Raising and the Occurring of Lactic Acid Streptococci in Milk and Dairy Products. The "Ordinary" Lactic Acid Bacterium. F. BANG, Milchw. Forschungsansalt in Kiel. Zentr. Bact. II, *95*, p. 390, 1937.

The development of lactic acid bacteria in the intestines of old and young pigs is incomparably easier than in the alimentary tract of cows and calves. *Streptococcus lactis* is able to grow in the intestinal canal of pigs, but not in cows. This is true, however, only if the pigs have been fed with cow's milk. Sucking pigs, on the other hand, do not harbor *S. lactis*. Air analyses of cow and pig stables demonstrated, that the pig stables are the veritable contamination sources of those lactic acid streptococci, which show a striking development in milk. There were only a few such streptococci found in the air of cow stables, if the latter were located far away from pig stables or from other farm buildings. *S. lactis* does not like to initiate growth on agar plates exposed to air, it is better to secure the organism on milk tubes by the method of the author.　　　　　　　　　K.J.D.

218. The New Proposed Procedure for Making Ice Cream Plate Counts. A. H. ROBERTSON, N. Y. State Dept. of Agr. and Markets, Albany, N. Y. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. 2, p. 132, Oct., 1936.

This is a report of comparisons made in five different ice cream plants between bacteria counts obtained by the use of standard nutrient agar and with tryptone-glucose agar at both 32° and 37° C. The tryptone-glucose agar was found to give definitely higher bacteria counts than standard nutrient agar. The higher count with tryptone-glucose agar is thought to be a more accurate criterion of the actual number of organisms present in ice cream than is the count secured with standard nutrient agar.

As to the incubation temperature, duplicate counts from the same dilution waters have been shown to be from 30 to 50 per cent less variable at 32° C. than at 37° C.

If the American Public Health Association should adopt tryptone-glucose agar as the official standard medium, this study would give the ice cream maker an idea of the effect of such a change on the total bacterial counts of ice cream.   M.J.M.

BUTTER

219. **A Study of the Several Minnesota Reagents for the Determination of Fat in Buttermilk.** E. W. BIRD AND D. F. BREAZEALE, Iowa State College, Ames, Iowa. JOURNAL OF DAIRY SCIENCE *20*, p. 1, Jan., 1937.

The fat content of buttermilk as determined by the Minnesota reagent was found to vary according to which one of the three suggested reagents was used.   A.C.D.

220. **A Study of the Churn Cleaning Methods Used by Plants Producing Butter of Various Yeast and Mold Counts.** H. A. BENDIXEN, State College of Washington, Pullman, Washington. JOURNAL OF DAIRY SCIENCE *20*, 1, p. 15, Jan., 1937.

Low yeast and mold counts in pasteurized cream butter indicated proper methods of churn sterilization which consisted of the use of churn wash water at 82–94° C. (180–201° F.) with total volume of $\frac{1}{3}$ to $\frac{1}{2}$ of the churn capacity, washing for 15 minutes, and rinsing with hypochlorite solution of 50 p.p.m. of chlorine or rewashing with hot alkaline wash water.
                                                                        A.C.D.

Other abstracts of interest are numbers 199, 200, 204, 205, 216, 222, 224, 225, 226, 227, 230, 234, 282, 283, 285, 288, 308, 311, 313, 314, and 318.

CHEESE

221. **Determination of Fat, Moisture, and Salt in Hard Cheese.** G. H. WILSTER, W. V. PRICE, A. J. MORRIS, E. F. GROSS, G. P. SANDERS, Oregon State Agr. College, Corvallis, Oregon. JOURNAL OF DAIRY SCIENCE *20*, 1, p. 27, Jan., 1937.

The authors gave specific directions for analyzing cheese for fat, moisture, and salt.   A.C.D.

CHEMISTRY

222. **Concerning the Theory of the Electrical Deacidification of Milk.** OTTO GRATZ. Le Lait *16*, 156, p. 611, June, 1936.

It is suggested that the theory of the electrical deacidification of milk put forth by Pien and Baisse (JOURNAL OF DAIRY SCIENCE, Abstracts, 19, 213, 1936) may not be correct. Gratz concludes that lactic acid is electrolyzed, the acid salts of the milk being converted to a basic form.   A.H.J.

223. Observations Concerning the Action of the Calcium Chloride Solution Used in the Preparation of Milk (to which alkaline carbonates have been added) for Refractiometry. A. TAPERNOUX, Vet. School at Lyons, France. Le Lait *16*, 158, p. 832, Sept.-Oct., 1936.

The solution used for clarifying milk to be used for the determination of the refractive index consists of 200 grams of calcium chloride made up to one liter with water. To 30 cc. of milk is added the proper amount of the above solution (usually 0.20 to 0.25 cc.). After shaking vigorously the solution is held at boiling temperature for 15 minutes. Usually the curd separates from the milk when subjected to this procedure and a clear liquid separates which is used in determining the refractive index. Occasionally the liquid thus obtained is not clear but is turbid and excessive foaming occurs during the preparation of the liquid. The addition of such alkaline substances as sodium bicarbonate, sodium carbonate, lithium carbonate and ammonium carbonate to the milk resulted in the obtaining of cloudy filtrates. It is therefore suggested that cloudy filtrates are obtained when the milk has been neutralized in processing. The addition of such preservatives as formalin or potassium dichromate to the milk did not affect its characteristic behavior with the calcium chloride solution.   A.H.J.

224. The Viscosity of the Fatty Matter in Butter. M. GORIAEW, Engineering Inst. of the Milk Industry, Leningrad, U.S.S.R. Le Lait *16*, 159, p. 943, Nov., 1936.

Determinations of the viscosity of the fatty matter of butter were made at 10° intervals between 30 and 100° C. (86 and 212° F.) inclusive. The viscosities in poises were respectively as follows: 0.258, 0.173, 0.124, 0.093, 0.071, 0.059, 0.049, 0.042. The cinematic viscosity (viscosity divided by the density at that temperature) and the fluidity of butter fat at these temperatures were calculated. The fluidity of butter fat was shown to be a linear function of temperature between 50 and 100° C. (122 and 212° F.) At 30° C. (86° F.) determinations of the viscosity of butter fat became more complicated because of the slow and partial solidification of the glycerides. For this reason the determination of the viscosity at temperature below 30° C. (8°6 F.) is not favored.   A.H.J.

225. The Influence of the Physical State of the Fat on the Calculation of Solids from the Specific Gravity of Milk. PAUL F. SHARP AND RAY G. HART, Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *19*, 11, p. 683, Nov., 1936.

It is necessary to warm milk to 113° F. followed by prompt cooling to 60° F. before determining its specific gravity or the results will not be constant due to the variable condition of the milk fat.   A.C.D.

226. The "Transition Point" of Milk Fat. G. A. RICHARDSON, Univ. of California, Davis, California. JOURNAL OF DAIRY SCIENCE *19*, 12, p. 749, Dec., 1936.

Milk fats produced under different feeding conditions have characteristic "transition points."   A.C.D.

227. Mercuric Chloride as a Preservative for Milk Samples Held for the Determination of Lactic Acid. H. C. TROY AND PAUL F. SHARP, Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *20*, 2, p. 77, Feb., 1937.

Milk samples can be preserved satisfactorily for lactic acid determination up to one month when not less than 0.5 per cent of mercuric chloride is added, followed by heating the sample to 80° C. for 5 minutes, then cooling and holding at 20° C., or lower, preferably in the dark.   J.C.H.

228. A Simple Plant Method of Estimating the Alkaline Constituents of Washing Powders and Washing Solutions Containing Mixed Alkalies. LAWRENCE L. LITTLE, Meadow Gold Milk Plant, Oklahoma City, Okla. JOURNAL OF DAIRY SCIENCE *20*, 2, p. 93, Feb., 1937.

A method is proposed for the analysis of a washing powder containing any or all of the cleaning alkalies—caustic soda, soda ash, trisodium phosphate and sodium meta silicate.   J.C.H.

229. Some Factors Influencing Fat Content in Ice Cream Mix and the Corresponding Finished Ice Cream as Determined by the Mojonnier Method. J. J. JOHNSON AND J. I. ORMOND, Sealtest System Lab., Baltimore, Md. JOURNAL OF DAIRY SCIENCE *20*, 3, p. 159, March, 1937.

Excessive shaking of melting ice cream samples caused fat separation which produced erratic variations in fat tests with a tendency toward low results.   A.C.D.

230. The Oxidation of Butterfat. I. The Catalytic Effect of Light, V. C. STEBNITZ AND H. H. SOMMER, Dept. of Dairy Ind., Univ. of Wisconsin, Madison, Wis. JOURNAL OF DAIRY SCIENCE *20*, 4, p. 181, April, 1937.

Dark green and dark red wrappers were most effective in screening out the ultra-violet light which accelerated the oxidation of butterfat.

A.C.D.

231. A Simple Method for the Detection of Copper in Alloys. B. L. HERRINGTON AND JOHN G. BRERETON, Dept. Dairy Ind., Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE *20*, 4, p. 197, April, 1937.

A simple test paper method is given by which the presence of copper in alloys can be easily detected.   A.C.D.

232. Comparison of Potentiometric and Colorimetric Methods of Determining the hydrogen ion Concentration of Nutrient agar. JOSEPH S. TAYLOR, Supplee-Wills-Jones Milk Co., Philadelphia, Pa. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 86, 1936.

Three agars were used; No. 1, unneutralized; No. 2, neutralized with 5 cc. of 0.2N NaOH per 400 cc.; No. 3 neutralized with 10 cc. 0.2N NaOH per 400 cc.

It was found that the pH as determined colorimetrically ran quite consistently 0.2 pH lower than the potentiometric value. There was no consistent difference in the counts and unneutralized agar is considered satisfactory. The colorimetric method is sufficiently accurate and has the advantage of ease and simplicity.   E.F.G.

CONCENTRATED AND DRY MILKS

Abstracts of interest are numbers 203, 205, 207, 208, 209, 210, 211, 222, 228, 231, 235, 276, 282, 296, 307, 308, 311, 312, 313, 315, and 316.

FOOD VALUE

233. American Medical Association Takes Stand on Vitamin D Question. Milk Dealer *26*, 5, p. 51, Feb., 1937.

Milk is the only common food which will be considered for acceptance by the American Medical Association when fortified with vitamin D, according to a decision by the Council on Foods of the American Medical Association. Requirements and allowable claims for vitamin D milk that may be made on bottle caps bearing the approval of the American Medical Association are also given.   C.J.B.

234. The Transmission of Vitamin A from Parents to Young in Mammals. V. The Vitamin A and Carotenoid Contents of Human and Colostrum milk. WILLIAM JOHN DANN, Dept. of Physiology and Pharmacology, Duke University School of Medicine, Durham, N. Y. Biochem. J. *30*, 1644, 1936.

Single samples of colostrum from 111 women and single samples of early milk from 104 of the women on uncontrolled relatively poor diets during pregnancy and after delivery, were examined for vitamin A and carotenoid content, employing for the tests, respectively, the Carr-Price method and the Lovibond tintometer.

According to a previous report on the milk of shorthorn cattle, the mean figures for cows' colostrum were 1253 B (Blue units) of vitamin A and 447 Y (Yellow units) of carotene per 100 ml. giving a total estimated biological

activity of 1055 I.U. per 100 ml. For the cow's milk, the corresponding figures were 30 B of vitamin A and 20 Y of carotenoids per 100 ml., giving a biological activity of 35 I.U. per 100 ml. The mean values for human colostrum are 629 B of vitamin A and 305 Y of carotenoids per 100 ml., giving an estimated biological activity of 632 I.U. per 100 ml. For human milk the corresponding values are 410 B of vitamin A and 120 Y carotenoid per 100 ml., giving an estimated biological activity of 346 I.U. per 100 ml. Thus the samples of human colostrum examined in this study average about half as much vitamin A and three-quarters as much carotenoids as the cow's colostrum; the total estimated activity being about three-fifths as great. On the other hand, the human milks were much richer than the cow's milks; they contained on the average about fourteen times as much vitamin A and about 6 times as much carotenoids and their biological activity was about ten times as great.

Since the ratio of concentration of vitamin A in human colostrum to concentration in human milk is small relative to the ratio for the cow (the mean figures being respectively 2.7 and 35) and since the volume of colostrum in the human subject is small, it appears human colostrum has no special function to perform in providing a special reserve supply of vitamin A for the infant at birth.   K.G.W.

235. **A Simplified Procedure for Calculating Weights of Milk to Their Energy Equivalent in Milk of Different Fat Content in Accordance with the Gaines Formula.** A. E. PERKINS, Ohio Agr. Exp. Sta., Wooster, Ohio. JOURNAL OF DAIRY SCIENCE *20*, 3, p. 129, March, 1937.

The author presents a simplification of the Gaines' Formula for calculating milk to the energy equivalent of milk containing four per cent of fat.
                                                              A.C.D.

ICE CREAM

236. **Know Your Ice Cream.** ROBERT C. HIBBEN, Intern. Assoc. Ice Cream Mfgrs., Washington, D. C. March, 1936.

This booklet is a presentation of important points in the manufacture of commercial ice cream. It is written in popular style and explains simply the various processes through which the product goes while being made into the finished product.

The booklet can be bought in quantity from the Ice Cream Merchandising Institute, 1105 Barr Building, Washington, D. C.   M.J.M.

237. **President's Address.** C. F. SAXON, President Controller's Council, I. A. I. C. M., French Bauer, Inc., Cincinnati, Ohio. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *3*, p. 7, Oct., 1936.

A high degree of managerial skill and intelligence is essential for progress

under present day business conditions. There is no substitute for the scientific method of exact inquiry as a basis for making decisions. The accountant must learn to use the methods of experimental and statistical inquiry as an aid in solving problems in management.

The program for the controller's council is a discussion of modern methods of statistical inquiry, relative costs, and trends in accounting.

M.J.M.

238. The Year's Activities. O'NEAL M. JOHNSON, Statistical and Accounting Bureau, Intern. Assoc. Ice Cream Mfgrs., Washington, D. C. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *3*, p. 8, Oct., 1936.

A demand for information as to trends in costs resulted in the publishing of Special Bulletin No. 53, entitled "Trends in Costs," by the International Association of Ice Cream Manufacturers. The Association has conducted an analysis of trucking costs, as well as Advertising and Package Analysis. These reports will be published soon.

The ice cream sales index figures have also been determined. A summary of these result is as follows:

	1936 compared with 1935	
	United States	Canada
	per cent	per cent
May	+ 39.56	+ 35.95
June	+23.49	+ 15.89
July	+ 19.33	+ 4.13
August	+19.42	− 1.16
May to Aug., Inc.	+ 24.06	+ 10.31
Jan. to Aug. "	+ 20.64	+ 9.82

M.J.M.

239. Why Accounting? O'NEAL M. JOHNSON, Statistical and Accounting Bureau, Intern. Assoc. Ice Cream Mfgrs., Washington, D. C. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *3*, p. 12, Oct., 1936.

Business accounting originally was a record of accounts receivable which could be used as a basis for collecting accounts. Gradually there developed from this the practice of keeping a record of accounts payable. The next addition to this was a record of all assets and liabilities and consequently, the preparation of a balance sheet with the resulting profit and loss statement was made possible.

The first big impetus to accounting was from the imposition of the income tax. Reasonably good accounting became necessary so that income, cost of sales, and expenses could be shown. Cost accounting has developed better business for accurate information as to products cost, manufacturing costs, delivery, sales, and distribution costs are now available. This information is

essential if the various costs are to be kept in line and costs are to be controlled. Recent Federal legislation, such as compensation insurance, old age annuities, the Robinson-Patman Law, etc., has placed a premium on good accounting.   M.J.M.

240. Experience with the Association Accounting System. GEORGE F.
MILLER, Miller Dairy Farms, Eaton Rapids, Mich. Proc. 36th
Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *3*, p. 19, Oct., 1936.

A description is given of the accounting needs in this particular business consisting of a dairy farm, an ice cream and milk plant, wholesale accounts, and several retail stores. The Accounting System of the International Association of Ice Cream Manufacturers proved very satisfactory and especially helpful in checking on the accounts of the retail stores which, previous to the installation, was extremely difficult.   M.J.M.

241. Customer Costs. C. F. SAXON, French-Bauer, Inc., Cincinnati, Ohio.
Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *3*, p. 49,
Oct., 1936.

There are few ice cream manufacturers who could not increase their sales by an increase in sales expense, but there is a point beyond which it is unprofitable to increase advertising costs.   The analysis of distribution costs by customers may offer an answer to the question of where and how to sell at a profit. Such an analysis should reveal the unprofitable as well as the low cost accounts. Consumer's costs should reveal where and how to sell at a profit.

The method by which the distribution costs by consumers can be determined is as follows:

1. Credit each customer with the gross margin produced from his business.
2. Deduct the costs of the functions securing this gross in the following order:
   a. Route delivery costs
   b. Special delivery cost
   c. Cabinet service
   d. Cost of personal selling
   e. Advertising
   f. Sales department overhead
   g. General company overhead
3. The foregoing information should show:
   a. Whether a satisfactory gross is produced
   b. At what point the gross will fail to cover its cost

The difficulties of analyzing distribution costs are great. The field is new and little standardized practice has been developed. The method of securing customer's costs as outlined should prove to be a better method than some others in ascertaining where and how to secure profitable gallonage.   M.J.M.

242. The Trend in Trucking Costs. R. E. SLONAKER, Philadelphia Dairy
Prod. Co., Philadelphia, Pa. Proc. 36th Ann. Conv. Intern. Assoc.
Ice Cream Mfgrs. *3*, p. 51, Oct., 1936.

There are three types of routes which should be considered:

      1. Peddle routes
      2. Combination peddle and telephone
      3. Telephone call order routes

A comparison of costs by the three systems shows that in 1932 by the
peddle system the delivery cost was 18.05 cents and for 1935, 13.93 cents.

For the second system the 1932 cost was 10.87 cents per gallon and in
1935 it was 8.22 cents per gallon.

For the third system the cost per gallon in 1932 was 6.75 cents per gallon
and in 1935, 7.22 cents per gallon.

The call order system is, therefore, cheapest in large cities where popu-
lation is dense, telephone costs per call are low, and trucking routes are
short. However, for the plant located in a small town many of the calls
would be toll calls. In this case one of the other types of routes should
be cheapest.

During the past few years the amount of packaged goods and novelties
has increased. This change has reduced the pay load approximately
twenty per cent during the peak season.

The more general use of mechanical cabinets in recent years has made
possible the use of lighter trucks, the lengthening of routes, and combining
of routes. These changes have lowered trucking costs. The use of
mechanically refrigerated trucks and the elimination of metal cans have
also lowered trucking costs.

For 1932 the average delivery cost per gallon for the entire company
was 9.56 cents while in 1935 the cost was 8.19 cents per gallon, a saving of
more than one cent a gallon.

Discussion, led by P. B. Beck, The Borden Co., New York, N. Y.

A graphic chart, showing the change in trucking costs from 1930 to
1936, was discussed. The chart showed a gradual decrease in trucking
costs from 1930 to 1936.   M.J.M.

243. The Merchandising Council's Activities in 1936. JAMES H. MEE-
HAN, Pres. Merchandising Council I. A. I. C. M., Philadelphia
Dairy Prod. Co., Philadelphia, Pa. Proc. 36th Ann. Conv. Intern.
Assoc. Ice Cream Mfgrs. *4*, p. 7, Oct., 1936.

The function of the Merchandising Council is to act as advisor to the
Ice Cream Merchandising Institute.

The Ice Cream Merchandising Institute has presented an extensive
line of point of sale advertising materials which have been used by many
ice cream manufacturers. The institute has also urged the standardization

of fountain services. A program of consumer publicity and public relations is planned by the institute. Publicity releases will be issued at bimonthly intervals. Research to determine the consumer attitude toward ice cream will be attempted.

The Merchandising Institute is preparing for sale a manual which deals with various phases of merchanding ice cream..   M.J.M.

244. A Layman's View of the Ice Cream Business. JERRY McQUADE, Editor, Drug Topics, New York, N. Y. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *4*, p. 12, Oct., 1936.

Many companies are merchandising their products through the medium of the drug store. The ice cream industry has not kept pace with many other industries in aiding the druggist to sell its product, according to the author. He suggests a more active sales program on the part of the ice cream industry. Cooperation with the druggist in making birthday and holiday specials, in distributing recipe booklets, and in the promotion of special sales is urged.   M.J.M.

245. Ice Cream's Value to Fountain Profits. A. B. HOPPE, Loft's Inc., New York, N. Y. Proc. 36th Ann. Conv. Intern. Assoc. of Ice Cream Mfgrs. *4*, p. 19, Oct., 1936.

Ice cream must be considered as a perishable product. Therefore the merchandising of ice cream offers a special problem in comparison with packaged goods. The ice cream manufacturer should educate the operator of the soda fountain to the special problems arising in the dispensing of this product so that reasonable returns are realized. The soda fountain can be made to return a net profit of 15 cents on the dollar to the druggist if the fountain is properly managed.   M.J.M.

246. The Ice Cream Manufacturer's Responsibility to his Dealers. A. H. DEWEES, N. W. Ayer and Sons, San Francisco, Calif. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *4*, p. 25, Oct., 1936.

Selling methods and advertising materials which should prove helpful to the ice cream dealer are discussed in detail in this paper.   M.J.M.

247. Retail Stores—Yes or No. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *4*, p. 48, Oct., 1936.

A discussion led by Louis J. Wainer, Penn. Dairies, Inc., Lancaster, Pa.

Whether or not retail ice cream stores should be operated depends largely on the specific local conditions of the market. The principal advantages of the retail store are as follows:

1. The retail store is a controlled outlet.
2. There is a positive control of the product.
3. A well-kept store in a new territory opens up a new market.

4. The retail store does not increase your sales expense.
5. Since the retail store is equipped for large gallonage, cabinet expense is lowered.
6. Advertising cost on a gallon basis is lower.
7. The retail store furnishes a medium for studying the selling of ice cream.
8. The retail store increases volume.
9. Per consumption of ice cream is increased by the retail store.

The principal disadvantages of the retail store are:

1. Securing a satisfactory location is absolutely essential.
2. Water and electrical costs are high.
3. Efficient individual store management is necessary.
4. Difficulty of finding suitable fountain employees.
5. Legislation in some states is detrimental.
6. The net return per gallon of ice cream is low.
7. A large volume must be sold through each store.
8. Many operating costs are increased.

   (a) Benjamin C. Brown
       New Orleans Ice Cream Co., New Orleans, La.

The retail store can be operated successfully only if the community selected is suitable, if rent is fair, if the spending power of the people is favorable, and if satisfactory prices can be obtained.

The present wholesale stops being serviced must be seriously considered. The idea of competing with one's established customers is a problem which must be solved.

   (b) Jos. Morrissey
       De Coursey Creamery Co., Kansas City, Kansas

The retail druggists and dealers have been the backbone of the ice cream industry. The retail dealer may not have put forth the same effort in selling ice cream as he has with other products. The ice cream store has given the ice cream manufacturer a greater incentive to push ice cream sales. With the low cost of raw materials these stores have flourished because of large servings, big value and the public price consciousness. But with higher material costs and other fixed costs the retail ice cream store will become unprofitable and the ice cream industry again will have to rely on retail dealers for profitable outlets.

   (c) Kenneth C. Poole
       Frostkist Ice Cream Co., Portland, Oregon

The ice cream manufacturer is going into a field with which he is unaccustomed when he opens retail stores. Additional capital must be provided and a reserve set up for various contingencies. The cost of retailing in the food field is comparatively high. It is generally conceded that failures are more common in the retail business than in wholesale production.

The wholesaler who has survived changing business conditions is advised to stay out of the retail field. However, if he decides to retail his product, then he should forget the wholesale business, employ a staff of retail merchandisers, and change his merchandising methods completely.   M.J.M.

248. Packages and Individual Services vs. Bulk Ice Cream. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *4*, p. 64, Oct., 1936.

A discussion led by Frank A. Carroll, Pittsfield Milk Exchange, Pittsfield, Mass.

The main advantages of packages and individual services are, (1) the brand can more effectively be identified by the consumer, (2) advertising is more effective, (3) the profit is fixed, (4) a more sanitary product is sold, (5) service is easier and faster, and (6) the dealer can carry a greater variety of kinds and flavors when the ice cream is packaged.

Bulk ice cream is still preferred by the majority of people. Another disadvantage is that ice cream shrinks in packages. Often the overrun is too high in packaged ice cream. Bulk ice cream is also easier to make and is more profitable.

(a) A. C. Routh, Esmond Dairy Company, Sandusky, Ohio

In present day competition survival in business is impossible with the sale of bulk ice cream alone. Furthermore, it is impossible now to divert business back to bulk ice cream because many types of retail packages are widely accepted by the consumer. The distribution of individual units of ice cream is advisable because people like novelty and novelties, and unit production is the only means by which the dealer can control size, quality, and prices to both dealer and consumer.

(b) George Sanderson, Haines-CeBrook Company, Lynn, Mass.

In 1935 equipment was installed in our business for making the "Rol Form" of individual service. This has measured up in every way with expectations. The gallonage of our dealers has increased; a substantial number of new accounts have been added; and dealers as well as customers are satisfied with the new form of product.

(c) G. G. Diffenbach, Abbotts Dairies, Inc., Philadelphia, Pa.

Bulk as well as packaged ice cream must be sold by any well organized business. However, consumers do prefer bulk ice cream as is evident from the fact that 15 per cent of sales is represented by packaged ice cream and the other 85 per cent is bulk. From 1926 to 1931, the percentage of package sales to total sales of ice cream for the entire country increased only 1.82 per cent. During those five years much effort was put forth to sell ice cream in packages. From this it is evident that the consumer resists the sale of ice cream in packaged form.

(d) Humphrey Daniel, Carry Ice Cream Company, Washington, D. C.

There are several reasons why the public prefers bulk ice cream : A dipped package is heavier than a plant filled package. Bulk is only frozen once, hence is smoother in texture than packaged ice cream which is frozen more than once. Bulk ice cream is higher in temperature when served and therefor better flavored. The ice cream manufacturer should realize the wisdom of centering his activities around bulk ice cream. He should help his dealers merchandize bulk ice cream by advertising and teach them to dispense ice

cream in such a way that satisfactory profits are realized. Time taken to pack bulk is compensated for in that the consumer is getting a product which he prefers and will buy more often.

It is wise to gather extra gallonage where it can be had by selling packages and individual services, but not when they displace the more profitable and consumer pleasing bulk. M.J.M.

249. The Importance of the Fat Globule Membrane in the Freezing of Ice Cream. C. D. DAHLE AND D. V. JOSEPHSON, Penn. State College, State College, Pa. Proc. 36th Ann. Conv. Int. Assn. Ice Cream Mfgrs. 2, p. 100, Oct., 1936.

It is well known that ice cream mixes made from butter, butter-oil, plastic and frozen creams as fat sources exhibit inferior whipping properties when compared to mixes in which sweet cream is the source of the butterfat. It has also been demonstrated that the addition of certain substances such as dried egg yolk, buttermilk or buttermilk powder to mixes containing butter decreases the time required to reach a definite overrun.

The purpose of this investigation was to determine the reason for the poorer whipping properties of ice cream mixes made from butter, butter-oil, frozen cream and plastic cream; and by definite experimental evidence, to point out the factors which are responsible for this inferior whipping ability.

The explanation for the above was found in the nature of the fat globule membrane surrounding the fat globule, consisting of a protein-phospholipid complex, which is essential for normal whipping of ice cream mixes.

Studies of "oiling off" in butter, frozen cream and plastic cream mixes showed that the fat separation in these mixes was responsible for their poor whipping properties. The whipping ability of these mixes was restored to normal by reestablishing the normal membrane directly on the surface of the fat globules. The beneficial effect of egg yolk on whipping was also found to be a fat globule surface phenomenon. Egg yolk and fat globule membrane material are both protein-phospholipid complexes, which undoubtedly accounts for their similar effects on whipping.

The plasma constituents of milk were found not to aid the whipping ability of butter mixes nor was the emulsifying of butter in skimmilk prior to its incorporation into the mix of any benefit. The addition of the fat globule membrane suspension, however, restored the whipping ability of butter mixes to normal.

The authors draw the following conclusions from their investigation :

1. The whipping ability of ice cream mixes made from butter, frozen cream, and plastic cream, is directly related to the degree to which the mixes "oil-off" during processing.

2. The cause for the poorer whipping properties of mixes which "oil-off" is that probably during the reemulsification of the fat, foreign membranes

are established on the surfaces of the newly-formed globules. These membranes are composed of a mixture of all of the surface-tension-active substances in the mix many of which are not conducive to good whipping.

3. The reestablishment of the normal fat globule membrane by emulsifying butter in a "membrane suspension" completely restores the whipping properties of the mix containing this reconstructed cream.

4. Whipping properties of ice cream mixes, made from butter or butter-oil, can also be restored to normal by first making stable emulsions of them with dried egg yolk as the emulsifying agent and then incorporating them into mixes.

5. The addition of "membrane suspension" or egg yolk directly to the mixed and in the same concentration as that used in the emulsions, results in partial restoration of whipping properties.

6. When butter is emulsified with egg or milk phospholipids, stable emulsions result and whipping properties are restored nearly to normal, while butter-oil, treated in the same manner, results in very unstable emulsions and little aid to whipping is noted. The results indicate that the protein of "curd" portion of the butter is largely responsible for the stability of the emulsions made with butter and the subsequent restoration of whipping properties. A hypothesis is offered, suggesting that the protein or "curd" portion of butter is largely membrane protein.

7. The preparation of the emulsion of butter with skimmilk before processing, results in a stable emulsion but is of no aid to the whipping properties of the mix. Buttermilk, used in the same way with butter aids whipping somewhat, while emulsions made with the "membrane suspension" restore whipping to normal.

8. Commercial vegetable lecithin and starch when used as emulsifiers of butter-oil produce very unstable emulsions and are both deterrents to overrun development.

9. To have normal whipping properties in mixes made from a butter or butter-oil, it is essential that a protein-phospholipid complex or membrane, be present on the surfaces of the fat globules in the mix. The use of egg yolk or "membrane suspension" which furnishes this adsorption complex in a relatively pure form, demonstrates this fact.   M.J.M.

250. **A Comparison of Pressure and Centrifugal Homogenization of Ice Cream Mixes.** J. C. HENING, N. Y. Agr. Exp. Sta., Geneva, N. Y. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. *2*, p. 117, Oct., 1936.

The improvement in body, texture, and quality of ice cream prepared from pressure homogenized ice cream mixes as compared with unhomogenized mixes is universally recognized. Centrifugal homogenization with a colloid mill is another type of homogenization. This study was conducted because

in the literature no data could be found comparing pressure and centrifugally homogenized mixes.

The two-stage homogenization of ice cream mixes at low pressures produced mixes which were similar in viscosity and size of fat globules to mixes processed with the centrifugal colloidal mill, except that the colloidal mill ice cream mixes contained no fat globule clumps. The ice creams prepared from these mixes containing gelatin were likewise similar in body and texture.

When ice cream mixes prepared without gelatin were homogenized with pressures on the first stage ranging from 4000 to 1000 pounds, decreasing at 500 pound intervals with a constant pressure of 500 pounds on the second stage, they showed a gradual decrease in viscosity from 4000 pounds to zero pressure. The colloidal mill mixes were a little less viscous than the unhomogenized mixes. The fat globules showed a slight increase in size from 4000 to 2500 pounds pressure with greater increases at each succeeding reduction in pressure.

The texture and quality of the ice creams were good at the high pressures with a trace of coarseness at the 2500 pounds pressure. The ice creams prepared from mixes processed at the lower pressures were coarse and the centrifugal colloidal mill ice cream was a trifle coarser than the unhomogenized ice cream.

When ice cream mixes prepared without gelatin were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage was decreased from 2000 to 500 pounds at 500 pound intervals, the 2500 first-stage and 2000 pound second-stage pressure mixes were more viscous, contained larger fat globule clumps and whipped a little less readily than the mixes with a greater difference in pressure between the first and second stage. The body and texture of the ice creams prepared from these mixes were similar.   M.J.M.

251. Distribution Costs of Products. W. C. BLUNK, Golden State Co., San Francisco, Calif. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs., Oct., 1936.

There are two important reasons for keeping accounts; first, to record and help preserve the business assets and, second, to assist in managing the business more efficiently.

The cost of distributing ice cream has a greater bearing on the ultimate sales value than any other single factor, consequently an important bearing on net profits. Grouping all routes together in figuring delivery costs gives an overall average. For managerial control we have found this overall average of little value and, therefore, find it necessary to figure costs for each route separately.

Mileage is frequently used as a basic factor in figuring route costs. "Time" proved to be a more accurate basis than mileage. Repeated studies

have shown us that the time factor follows more accurately labor costs, truck depreciation, and even truck maintenance or gas and oil consumption than any other factor. Seasonal variations in consumption must also be determined in a study of distribution costs.

For each of our routes a graph is made on which the total costs per unit (plus "budgeted earnings") is plotted against the number of units delivered daily. When the units delivered daily crosses the line of total costs, the route is obviously a profitable one.

Graphs for three different routes are shown and their significance is explained. In these charts the costs involved in the operation of an ice cream route are shown graphically in such a way that they should prove helpful to one interested in determining delivery costs.

Discussion, led by Jesse S. Bloom, Abbott's Dairies, Inc., Philadelphia, Pa.

Until recently ice cream manufacturers have taken an academic interest in the matter of distribution costs. Many companies have determined other costs carefully but have lumped delivery or selling costs into one sum. It appears essential that in the future distribution costs must be figured with sufficient accuracy that these cost figures be acceptable to Federal taxing agencies.   M.J.M.

252. Sonic Vibration of Ice Cream Mixes. E. O. ANDERSON, Conn. State College, Storrs, Conn. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. 2, p. 126, Oct., 1936.

In this study mixes treated by sonic vibration were compared with pressure homogenized mixes.

An electromagnetic oscillator similar to those used in submarine communication and echo depth sounding consisting essentially of a heavy, loaded, steel membrane actuated by alternation in an electromagnetic circuit was used. The rate of oscillation of the diaphragm was 360 cycles per second. The opening through which the ice cream mix passed between the diaphragm and the reflecting plate could be reduced to any desired value in steps of 0.01 inch. The capacity of the oscillator was 250 gallons an hour.

The results of the experiment show that when ice cream mix is directed to the oscillator under positive pressure, the freezing and whipping time of the oscillated mix compares favorably with that of homogenized milk. In some instances the time required to reach 100 per cent overrun was less with oscillated treated than with homogenized milk.

The body and texture of an oscillated gelatin and egg powder mix compared favorably with homogenized mix made from the same ingredients.

A small amount of gelatin was found necessary to secure a smooth body with oscillated mix both in the continuous and batch freezer as compared with homogenized mix.

When butter was used as the source of fat oscillated mix made as smooth a product as homogenized milk.

The simple construction of the oscillator makes it easy to clean and sterilize. The apparatus is very simple to operate. M.J.M.

253. Analysis of Ice Cream Sales. Special Bulletin No. 55. Intern. Assoc. Ice Cream Mfgrs., 1105 Barr Building, Washington, D. C. March, 1937.

This bulletin contains an analysis of sales of bulk and package ice cream and novelties for the year 1935. Bulk ice cream sales represented 58.6 per cent of total sales, cups 4.12 per cent, novelties and specialties 20.32 per cent, and packages 17 per cent. Though bulk sales represent a major portion of total sales, there has been a definite increase in the sales of packages and novelties.

The exact profits for the various kinds of ice cream were not determined. However, 94.62 per cent of the manufacturers reporting stated that bulk ice cream was most profitable. To the question, Why have you developed the sale of packaged ice cream, 36.33 per cent of manufacturers said, to meet competition; 26.17 per cent, to meet consumer demand; 23.44 per cent, to meet dealer demand; 11.72 per cent, to utilize advertising space on the packages; and 2.34 per cent, so as to sell two qualities of ice cream. M.J.M.

254. A Comparison of Pressure and Centrifugal Homogenization of Ice Cream Mixes. J. C. HENNING, N. Y. Agr. Exp. Station, Geneva, N. Y. JOURNAL OF DAIRY SCIENCE *19*, 11, p. 707, Nov., 1936.

When homogenizing with the two stage pressure machine the texture of the ice cream was best when the first valve pressure exceeded 2500 pounds and the mix viscosity was lowest with a pressure of 500 pounds on the second stage. The centrifugal homogenizer was not as satisfactory as the pressure machine for ice cream purposes. A.C.D.

255. Why Do They Eat Ice Cream? P. H. TRACY, Univ. of Illinois, Urbana, Illinois. Ice Cream Trade J. *31*, 8, p. 11, Aug., 1935.

Students in ice cream manufacturing have for several years recorded the reasons people gave for eating ice cream. These people were of various ages, both sexes, and employed in many different occupations. Of the 1422 persons studied most of them said they eat ice cream because of its palatability. This fact alone should point out to ice cream manufacturers the necessity of using high quality ingredients, proper sanitation, and proper handling. The second important reason given for eating ice cream was the refreshing sensation it gives the consumer. Hence care must be used to regulate the solids content of ice cream as a high solids content does not give the cooling effect that a low solids ice cream will. Twelve per cent of those questioned gave food value as their reason for eating ice cream. Convenience was an important factor in trade with housewives. Of the 1422

persons that gave reasons only 49 objected to it.   A suggested motto for the industry might be "Nine hundred ninety-three out of every thousand like it."   W.H.M.

256. Using Frozen Cherries in Cherry Ice Cream.   J. C. HENING, N. Y. State Agr. Exp. Station, Geneva, N. Y.   Ice Cream Trade J. *31,* 11, p. 16, Nov., 1935.

Recent experimental studies using five different common varieties of cherries, previously frozen, in the manufacture of cherry ice cream points out that two of these varieties are better than the others.   They are: the Giant and the Napoleon sweet.   The Montgomery was best of the other varieties, although Phillipe and Royal Duke were good.

The cherries were packed in the ratio of four parts cherries to one part sugar in the first trials, but this amount was not sufficient.   The cherries were added to the freezer near the beginning or middle of the freezing process.   Addition of extra sugar to the mix was not as satisfactory as adding it to the cherries.

A satisfactory cherry ice cream can be made as follows: add 11 pounds of Montgomery cherries packed 4 to 1 plus 2.5 pounds of sugar, thawed and soaked in their own syrup for 20 hours, to 31.5 pounds at the start of the freezing process.   After hardening the cherries were not hard or icy and gave and excellent flavor to the ice cream.   W.H.M.

257. Sodium Alginate as a Stabilizer in Manufacturing Ice Cream. M. J. MACK, Mass. State College, Amherst, Mass.   Ice Cream Trade J. 32, 11, p. 33, Nov., 1936.

Sodium alginate, when properly incorporated in the mix, proved to be satisfactory stabilizer for ice cream.   Advantages claimed for this stabilizer in ice cream are: no aging of mix is necessary, a higher maximum overrun can be obtained when the whipping period is prolonged, the mixes whip more rapidly and reach 100 per cent overrun more quickly than those containing gelatins, and it is more effective than other stabilizers in improving the texture of the ice cream.

Considerable precaution must be taken in order to secure a satisfactory solution.   The mix should be heated to 160° F. before the sodium alginate is added, failure to do so will result in sticky, somewhat insoluble lumps.

The amount of sodium alginate used in a mix is approximately the same as the amount of gelatin used.   The recommended methods of adding sodium alginate to the mix are: (1) Mix the sodium alginate through part of sugar, and then sift this sugar-stabilizer mixture slowly over the surface of the hot mix (160° F.–165° F.)   W.H.M.

258. Trends in Ice Cream Costs.   O'NEAL M. JOHNSON, Statistical and Accounting Bureau, Intern. Assoc. Ice Cream Mfgrs.   Ice Cream Trade J. *32,* 11, p. 37, Nov., 1936.

The author divides ice cream costs into: product cost, manufacturing expense, selling expense, delivery expense, and administrative expense, and gives a five year trend (1931–1936) of these various items for the United States as a whole and by districts.

The five year trend for the United States shows a decrease in total, delivery, distribution, manufacturing and administrative costs, and an increase in production and sales expense.

The facts presented can be used as a measuring stick of the efficiency of the individual manufacturer, and should yield such information which can be used to reduce the cost of the ice cream manufacturer. W.H.M.

259. The Industry: Advertising. Anonymous. Ice Cream Trade J. *32,* 12, p. 9, Dec., 1936.

Statistical information compiled by the International Association of Ice Cream Manufacturers showed an expenditure of $5,660,000 for advertising, or 2.83 cents per gallon, in 1935.

Quality appeal is the item used most in advertising. Economy and convenience appeals were used the least. Seventy per cent of the advertising done was devoted primarily to the consumer.

The main advantages of an advertising budget are that it makes possible a well planned and well balanced advertising campaign, and makes it easier to control the advertising activities. W.H.M.

260. Finding the Distribution Cost. W. C. BLUNK, Golden State Co. Ltd., San Francisco, California. Ice Cream Trade J. *32,* 12, p. 17, Dec., 1936.

The cost accounting of ice cream business can be divided into three important phases; namely, product cost, manufacturing cost, and distribution cost. The distribution cost is the more complex of the three.

The cost of distributing ice cream has in many respects a greater bearing on the ultimate sales value than any other single factor, and consequently it has a very important bearing on the final net profit.

Time is the most common factor in the distribution cost, and has a direct bearing on labor cost and truck depreciation.

The type of service, stops at hotels and restaurants, or straight store delivery are factors in the cost of distribution. The route serving hotels and restaurants is put at a disadvantage when compared to a route serving only straight store stops.

Distribution costs for various kinds of stops are given. W.H.M.

261. Locating, Equipping, and Operating Retail Stores for Ice Cream. CLYDE A. FOWLER, Ice Cream Trade J. *32,* 12, p. 21, Dec., 1936.

The author discusses the essential factors of a successful ice cream retail store. W.H.M.

262. Improved Refrigeration Facilities will Lower Production costs.
HERMAN VEHEI.   Ice Cream Trade J. *32*, 12, p. 25, Dec., 1936.

The author gives 0.319 KW-hr. per gallon of ice cream as a theoretical cost basis for a plant.   He derived this figure by taking into account the following items:

Ammonia compressor	0.185
Condenser pump	0.040
Pasteurizer	0.004
Homogenizer	0.004
Ripening vats	0.008
Aerator water pump	0.004
Freezer	0.060
Room load	0.014

0.319 KW-hr. per gallon

If it is desired to make comparisons of a plant, the author states that the power consumption should not exceed 0.71 KW-hr. per gallon if load factor is 45 per cent.   To obtain correct load factor, divide your average monthly production by your greatest monthly production.   To obtain power consumption, divide the theoretical cost per gallon by load factor.   W.H.M.

263. A Five Point Sales Program.   W. J. MONAGHAN, Borden Co., New York, N. Y.   Ice Cream Trade J. *33*, 3, p. 14, Jan., 1937.

Wholesale ice cream manufacturers have had to change their merchandising methods since the introduction of the manufacturers owned retail stores.   An analysis of the factors responsible for large volume of ice cream sales in retail outlets indicated that success was due to the fact that they were specialty stores, dominated by ice cream, with plenty of light, offering a wide variety of flavors and better values.   To compete with this new competition a five point program was suggested for increasing the per capita consumption of ice cream.   In the main it consists of, developing the right attitude in the organization towards ice cream, securing a sympathetic attitude on the part of the dealer towards ice cream, and follow through with a well planned advertising and sales promoting campaign.   W.H.M.

264. Sales for 1936 Swing Upward.   O'NEAL M. JOHNSON, Intern. Assoc. Ice Cream Mfgrs.   Ice Cream Trade J. *33*, 1, p. 31, Jan., 1937.

Statistics collected from 673 plants in the United States and 23 Canadian plants showed an increase of 20.64 and 9.82 per cent respectively for the period January 1 to August 31, 1936, over the same period in 1935.   Better business conditions and favorable weather were the contributing factors.

W.H.M.

265. Advertising Appeals.   Editorial, Ice Cream Trade J. *33*, 1, p. 35, Jan., 1937.

When the advertising themes used by ice cream manufacturers are compared with the reasons given by consumers for eating ice cream, indications are that too much advertising is directed to food value and too little to the sensory appeals. The following table of percentages taken from two recent surveys is presented to illustrate these facts.

Percentages compared	Advertising themes	Why consumers eat ice cream
Sensory appeals	32 per cent	69.3 per cent
Food and health value	26.6	12.3
Convenience	3.5	7.8
Economy	2.3	2.2

W.H.M.

266. Problems of Freezing Ice Cream by the Continuous Method. R. J. RAMSEY, Telling-Belle-Vernon Co., Cleveland, Ohio. Ice Cream Trade J. *33*, 2, p. 21, Feb., 1937.

The composition of the mix, the method of processing, and freezing are somewhat different than for the batch freezer. Special recommendations for operating the continuous freezer are 4 to 6 hours aging period for the mix, 35 to 40° F. temperature of mix at the freezer, 3 pounds back pressure on the ammonia compressors for freezing, operation of freezers at recommended capacity, 22° F. freezing temperature, and regulate overrun with air valve only. A list of advantages and disadvantages of the continuous freezer is also presented. W.H.M.

267. What the Man Behind the Fountain Should Know About Ice Cream. E. N. BURNS, Garber, Peters, and Jacoby Co., Inc., Allentown, Pa. Ice Cream Trade J. *33*, 2, p. 29, Feb., 1937.

This paper discusses some of the important points in which fountain men should be trained about ice cream in order that sales of ice cream may be increased.

The topics discussed are—history of the ice cream industry, processes of manufacture, control of manufacture, place of local company in the community, food value of ice cream, profit value of ice cream, weight of ice cream, proper materials to use with ice cream, the right method of dipping ice cream, correct temperature for dipping ice cream, proper glassware at the soda fountain, rotation of packaged ice cream, cleanliness at the fountain, proper display of advertising, power of suggestion, and the fancy form business and its possibilities. Considerable information of value to soda fountain operators is given in this article. W.H.M.

268. Build Your Merchandising Program on the Confidence of Consumers. W. H. E. REID, Univ. of Missouri, Columbia, Mo. Ice Cream Trade J. *33*, 3, March, 1937.

The author described various ways for improving the consumer-acceptance of ice cream. Maintenance of high quality, proper attention to sanitation at the point of sale, serving at the correct temperature, and the protection of ice cream against deterioration after it leaves the hardening room were some of the topics discussed. By devoting the necessary attention to the choice of high quality raw materials, effective processing and freezing of the ice cream, and the adoption of an efficient merchandising program, consumer's acceptance may be enhanced.   W.H.M.

269. **The Profitable Retail Store.** KENNETH WALLACE, Franklin Creamery Co., Cleveland, Ohio. Ice Cream Trade J. *33*, 3, p. 13, March, 1937.

The success of the retail store, which now is an established outlet for ice cream, will depend upon the intelligent application of the principles of good management. Product, service and price are the three essential factors which will determine the success of the store.   W.H.M.

270. **You Can't Do a Merchandising Job if You Don't Have Proper Tools.** GEORGE HENNERICH, Mgr., Ice Cream Merchandising Institute, Inc. Ice Cream Trade J. *33*, 3, p. 17, March, 1937.

Merchandising of ice cream has not kept pace with improvements in manufacturing facilities. In order that a better job of merchandising ice cream may be done, the Merchandising Institute has prepared a number of tools which may be used. The author gives specific information on how these various tools may be used advantageously by the ice cream salesman.   W.H.M.

271. **Bigger Sales for Ice Cream** AUBYN CHINN, National Dairy Council, Chicago, Illinois. Ice Cream Trade J. *33*, 3, p. 23, March, 1937.

This article describes material presented at many ice cream conventions throughout the United States during the past few months. The author suggests the following sales potentialities for ice cream.

·1. Place before the professional leaders in the medical and educational fields, the quality and superior food value of commercial ice cream.

2. Integrate projects and material on ice cream in the regular educational program in schools.

3. Increase consumer education through all channels such as newspaper editorials, leaflets for direct mail to consumers, food demonstrations.

4. Stimulate increased use of ice cream for young adults in factories and offices for between-meal pick-up through appeals to beauty, weight control, and physical fitness.   W.H.M.

272. **Ice Cream in the 1935 Census.** Anonymous. Ice Cream Trade J. *33*, 3, p. 27, March, 1937.

Data collected by the Bureau of Census indicate the production of 237,-

258,394 gallons of ice cream, ices and specialties in the United States during 1935 representing an increase of 52.6 per cent over the 1933 production. Other interesting statistics presented include the number of wage earners, wages paid, cost of materials, value of product, and the amounts of various frozen products manufactured.   W.H.M.

273. What Should Stabilizers Do? V. C. STENNITZ, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wis. Ice Cream Trade J. *33*, 3, p. 35, March, 1937.

The author of this article lists the purposes for which stabilizers are used in ice cream, classifies stabilizers and discusses the advantages and disadvantages of various stabilizers. Most of the discussion deals with the merits of sodium alginate as a stabilizer for ice cream. He concludes, "Sodium alginate as an ice cream stabilizer appears to posses all the desirable properties of gelatin and in addition has some distinct advantages. Notable among these advantages are the uniformity of viscosity of the mix, the faster shipping, and the desirable melt-down of the ice cream."

W.H.M.

274. Applying to Ice Cream the Minnesota Babcock Butterfat Test. L. M. THURSTON AND W. C. BROWN, Dept. Dairy Husb., West Va. Univ. Ice Cream Field *30*, 4, p. 8, Feb., 1937.

The authors summarize the results of this study, which was designed to compare the accuracy of the Minnesota Babcock test with the gravimetric method, as follows:

1. The Minnesota method failed consistently to give satisfactory results either with chocolate milk or chocolate ice cream.

2. Satisfactory results were obtained for ordinary ice cream and concentrated milks when the following conditions are taken into consideration.

(a) Samples digested at temperatures of 200°–210° F. yielded more nearly accurate results, on the average, than those digested at 180°–185° F.

(b) The accuracy of the test with ice cream and concentrated milks varied with the shaking procedure during digestion. Shaken samples tended to yield results that are too high, whereas the unshaken samples tended to yield results that were too low. The best results were obtained by shaking the samples vigorously at the time when at least half of the contents of the bottle have turned dark brown (usually about 2½ minutes after placing them in the water bath). The samples should be shaken vigorously again about one minute later.

(c) Digestion periods of 20 minutes or longer tended to give results that became progressively lower as the time of digestion bath increased. However, the reduction in reading due to 15 minutes digestion as compared to that due to 10 minutes is not great and would not seem to be a factor seriously affecting the accuracy of the test. Observations on the digestion of

the samples at the temperature of boiling indicate 10 minutes is required as a minimum for satisfactory results. Accordingly, a digestion period of 10 to 15 minutes is recommended.

(d) The use of a reading fluid is recommended, because it causes sufficient reduction in the results to cause the samples that were shaken vigorously during digestion. and consequently gave high results which did not vary more than 0.1 per cent on the average from the results shown by the gravimetric method.   W.C.

275. Facts About Ice Cream the Soda Dispenser Should Know Thoroughly. E. N. BURNS, Mgr. Garber-Peters Jacoby Ice Cream Co., Allentown Pa. Ice Cream Field *30*, 5, p. 18, March, 1937.

The author claims among other things that in order to have the dispenser enthusiastic about the ice cream which he sells he should be familiar with: the historical development of the industry, the process of manufacture of ice cream and the provisions for control of its quality, and the food value of ice cream. He states that often ice cream specials sell for more than they should and conclude that "a soda fountain product containing ice cream should not be sold for more than twice the cost of the ingredients."

He emphasizes the necessity of teaching the dispenser how to dip ice cream, how to keep the fountain clean, and how to properly display advertising material.   .   W.C.

Abstracts of interest are numbers 198, 201, 205, 207, 208, 209, 210, 211, 218, 228, 229, 230, 231, 232, 235, 276, 277, 278, 279, 280, 282, 283, 284, 285, 287, 288, 289, 291, 296, 305, 307, 308, 309, 311, 312, 313, 314, 315, 316 and 317.

MILK

276. The Grading of Raw Milk on the Basis of Bacterial Cleanliness. G. S. WILSON, London School of Hygiene and Tropical Medicine, London. England. Proc. 29th Ann. Conv. Intern. Assoc. of Milk Dealers, Lab. Section, p. 11, 1936.

After a discussion of the most important available tests reasons are brought to show that a modified methylene blue reduction test is peculiarly well suited for the grading of raw milk. The test is modified by holding the samples at atmospheric temperature for a definite period of time before adding the methylene blue to permit the heavy contamination of milk produced under bad sanitary conditions to become operative, and by stoppering and inverting the tubes each half hour during the test to break up the cream layer and secure more uniform reduction.   E.F.G.

277. Factors Affecting the Viscosity of Market Cream. H. B. HENDERSON, Univ. of Tenn., Knoxville. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 21, 1936.

Various conditions of separation, agitation, heating and cooling of milk in many cases resulted in significant differences in the viscosity of raw cream but in the pasteurized product these differences were not large enough to be of very great significance.

With regard to increasing the viscosity of cream by the method described by Hening and Dahlberg the viscosity of fresh and aged pasteurized cream was increased by subjecting the cream to a temperature treatment of 80° to 90° F., the greater increase being obtained with a temperature of 80° F. E.F.G.

278. **Discussion of Factors Affecting Cream Viscosity.** A. C. DAHLBERG, N. Y. Agr. Exp. Sta., Geneva. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 36, 1936.

A heat treatment of cream to increase viscosity recently developed at Geneva and previously published is discussed. E.F.G.

279. **Control of the Oxidized Flavor in Milk.** GEORGE R. GREENBACK, U. S. Dept. of Agr., Washington, D. C. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 101, 1936.

When cows go on pasture the "oxidized" flavor does not always disappear.

The oxidized flavor may develop in the milk at any time during the lactation period. It is believed that the flavor is the result of the oxidation of a minor constituent. The protective action of ascorbic acid is shown. Copper was found to be the best catalyst in producing this flavor. Ferrous iron is catalytic but ferric iron which is an oxidizing agent is an inhibitor especially in higher concentrations. Different milks vary greatly in copper tolerance.

Milks having the lowest oxidation-reduction potentials were best. An increase of 0.1 pH was sufficient to prevent the development after 24 hours in storage and decrease the intensity after 48 hours. Aeration increased copper tolerance four times while pasteurization increased it eight times. Aeration plus pasteurization gives the greatest protection.

Elimination of metallic contamination is the first step in preventing development of the oxidized flavor in milk. E.F.G.

280. **The Cause of Oxidized and Rancid Flavors in Raw Milk.** J. A. ANDERSON, Rutgers Univ., New Brunswick, N. J. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 117, 1936.

By feeding experiments it was shown that it was possible to cause a change from the production of good milk to milk which acquired either oxidized or rancid flavors simply by changing from machine cured alfalfa hay to poor field cured alfalfa. It was also possible to cause these same

animals to produce milk of good color and flavor by feeding a good quality of hay or a poor hay plus a small quantity of carrots.

The factor or factors responsible for the production of milk of good flavor is present in alfalfa dried in such a manner as to conserve color and certain accessory food factors, one of which is carotene or provitamin A. In poor field cured alfalfa these factors are deficient. The factor or factors appeared to be present in good red carrots to a considerably greater extent than in alfalfa.

In order to determine whether the good factor we are seeking is actually carotene or something associated with it in plant materials we are now preparing to feed one of the most expensive compounds ever fed to a cow, pure carotene.   E.F.G.

281. **Flavors of Milk Influenced by Different Systems of Feeding Certain Roughages.** C. L. ROADHOUSE AND J. L. HENDERSON, Univ. of California, Davis. Proc. 29th Ann. Conv. Intern. Assoc. Milk Dealers, Lab. Section, p. 135, 1936.

Some new data are reported concerning the effect of alfalfa hay, corn silage, alfalfa pasturage, sudan grass pasturage, and concentrates upon milk flavor score when fed at various intervals and in various amounts with relation to the milking period. A practical procedure for controlling feed flavor in milk when the above are used is given. This includes, (1) concentrates during milking, (2) alfalfa' hay immediately after milking, (3) alfalfa pasture just after milking and until four or five hours before milking, (4) free access to sudan grass pasturage until just before milking, (5) if as much as fifteen to twenty pounds of corn silage is fed it is always best to feed it after milking.

Although ideal procedure would be to withhold all roughage from the cows during the five hour period before milking the above procedure will produce a commercially acceptable milk.   E.F.G.

282. **The Cleaning of . Tinned Equipment in the Dairy.** G. GENIN, Engineer E. P. C. Paris, France. Le Lait *16*, 156, p. 611, June, 1936.

The corrosion of tin and tined copper by sodium carbonate and caustic soda solutions depends essentially on the quantity of oxygen dissolved in the solution and very little on the temperature and concentration of the alkali. The presence of a reducing agent allows a marked reduction in the corrosion. For this purpose sodium sulphite was found very effective. Thus pure tin on treatment with 0.5 per cent solution of sodium carbonate lost 6.6 mg. per square decimeter while when the carbonate solution contained sodium sulphite the loss was reduced to 0.8 mg. per square decimeter. Sodium sulphite has the advantage of low cost, relative stability in a solid

state, and ready solubility in water and in alkaline solution. Moreover its product of oxidation, sodium sulphate exerts no deleterious effect. By the addition of sodium sulphite, it is possible to reduce to about 1/10 the attack of alkaline solutions on tin. It is suggested that proper proportions of mixing sodium sulphite and carbonate or caustic are 1 part of sodium sulphite to 10 parts of crystallized sodium or 1 part of sodium sulphite to 4 parts of sodium carbonate or caustic soda. The protective action of the sodium sulphite on tin is exerted until all of it has been oxidized to the sulphate.   E.H.J.

283. Variations in the Carotene and Vitamin A Values of the Milk Fat (butter) of Cattle of Typical English Breeds. ALBERT EDWARD GILLAM AND ISADOR MORRIS HEILBRON, Chem. Dept., Manchester Univ., and William Swan Ferguson and Stephen John Watson, Imperial Chemical Industries Ltd., Jealott's Hill Research Station. Biochem. J. *30*, 1728, 1936.

Two cows from each of the main dairy breeds, Shorthorn, Ayrshire, Friesian and Guernsey, all having calved between October and November, were selected. During the last three months of the year, the winter ration consisted of hay, kale and concentrates, the kale being fed at the rate of 30–40 pounds per day. From January to April, the kale was replaced by mangolds. In May and June pasturage was plentiful, but July drought seriously affected the supply of grasses. Butter was prepared from the colostrum, and from the milk thereafter at monthly intervals. The carotene and vitamin A were determined on the unsaponifiable matter by absorption spectra methods. The results show that individual variations among the cows of the same breed are large but that the carotene and vitamin A values are more dependent upon diet than on the stage of lactation. For the four breeds, Shorthorn, Ayrshire, Friesian, and Guernsey, the following gross average values expressed as Mg./100 gm. fat on the normal milk were Carotene, 0.27; 0.36; 0.40; 0.92. For vitamin A, 0.68; 0.85; 0.90; 0.75. For calculated growth promoting activities as Y per gram (B carotene units) 9.5; 12.1, 13.0; 16.7. High vitamin A and carotene values were observed in the colostrum milk. Approach of the end of the lactation period does not appear to affect the vitamin A or carotene values.

The vitamin A may vary as much as 300 per cent and the carotene 400 per cent during the lactation period.   K.G.W.

284. Variations in the Vitamin C Content of Milk. C. H. WHITNAH AND W. H. RIDDELL, Kansas Agr. Exp. Sta., Manhattan, Kansas. JOURNAL OF DAIRY SCIENCE *20*, 1, p. 9, Jan., 1937.

The vitamin C content of fresh cow's herd milk could not be materially increased by feed but remained fairly constant at 23 to 30 milligrams per liter.   A.C.D.

285. The Rate of Change in the Vitamin A Content of Milk. W. C. Loy, J. H. Hilton, J. W. Wilbur and S. M. Hauge, Purdue Univ. Agr. Exp. Sta., Lafayette, Indiana. Journal of Dairy Science *20*, 1, p. 31, Jan., 1937.

About 11 days were required for changes in vitamin A in the feed of cows to reach an equilibrium level in the milk.   A.C.D.

286. The Composition of the Colostrum of the Dairy Goat. A. J. Bergman and C. W. Turner, Univ. of Missouri, Columbia, Mo. Journal of Dairy Science *20*, 1, p. 37, Jan., 1937.

The composition of the colostrum of the milk of six goats was determined for a period of nine days following parturition.   A.C.D.

287. The Relation of the Oxidation-Reduction Potential of Milk to Oxidized Flavor. R. E. Webb and J. L. Hileman, Dairymen's League Coop. Assoc., Syracuse, N. Y. Journal of Dairy Science *20*, 1, p. 47, Jan., 1937.

In general a relationship was found to exist between the oxidation-reduction potential of milk and the tendency to develop oxidized flavor.

A.C.D.

288. A Further Study of the Factor in Soybeans Affecting the Vitamin A Value of Butter. S. M. Hauge, J. W. Wilbur and J. H. Hilton, Purdue Univ., Agr. Exp. Sta., Lafayette, Indiana. Journal of Dairy Science *20*, 2, p. 87, Feb., 1937.

The vitamin A suppressing factor in soybeans which interferes with the transference of the vitamin A activity of the feed to the butterfat secreted by dairy cows was found to be distributed in both the soybean oil and soybean oil meal secured by either the expeller process or by chemical solvents.

J.C.H.

289. Oxidized Flavor in Milk. IV. Studies of the Relation of the Feed of the Cow to Oxidized Flavor. W. Carson Brown, L. M. Thurston, and R. B. Dustman, West Va. Agr. Exp. Sta., Morgantown, West Va. Journal of Dairy Science *20*, 3, p. 133, March, 1937.

Green feeds fed to cows altered the milk to distinctly decrease the tendency toward oxidized flavor.   A.C.D.

290. The Use of Formate-Ricinoleate Broth in Controlling and Preventing Ropy Milk Epidemics. L. R. Curtis, Dairymen's League Coop. Assn., Syracuse, N. Y. Journal of Dairy Science *20*, 3, p. 147, March, 1937.

Formate-ricinoleate broth was found to be very effective in detecting sources of plant contamination of the milk supply with ropy milk bacteria.
A.C.D.

291. A Study of Oxidized Flavor in Commercial Pasteurized Milk. C. T. ROLAND, C. M. SØRENSEN, AND R. WHITAKER, Sealtest System Labs., Inc., Baltimore, Md. JOURNAL OF DAIRY SCIENCE *20*, 4, p. 213, April, 1937.

Oxidized flavor was found to be the predominant flavor in commercial pasteurized milk and it occurred in 21 per cent of the samples.   A.C.D.

292. Britain's Largest Dairy. JOHN ASHTON, Corpus Christi, Texas. · Milk Dealer *26*, 4, p. 34, Jan., 1937.

The author gives a complete description of the Express Dairy Co., Ltd., which serves millions of consumers in London and vicinity.   C.J.B.

293. Factors Influencing the Formation of Milk Layer in Bottled Coffee Cream. L. H. BURGWALD AND J. L. MOONEY, Ohio State Univ., Columbus, Ohio. Milk Dealer *26*, 4, p. 40, Jan., 1937, Milk Dealer *26*, 5, p. 72, Feb., 1937.

This work was undertaken in an effort to determine some method whereby plant practice might be adapted to the control of the formation of milk layer in the bottled coffee cream, as sold on the market.

Customary milk plant practice is established as pasteurizing the milk at 145° F., cooling to a temperature of about 110° F. and separating. Coffee cream is usually secured by standardizing heavy cream to the desired fat content by use of either whole or skimmilk. The maximum milk layer at the end of 12 hours, when creamed at a temperature of 42 to 50° F., was 13.10 per cent of the total volume, the minimum milk layer was 1.28 per cent of the volume.

Seasonal influence is a factor in the formation of the milk layer. Control of the milk layer is more difficult in the spring of the year.

Pasteurization of the milk at 155° F. and separating at 110° F. reduced the amount of milk layer. Likewise, the pasteurization of the cream at 155° F., for 30 minutes reduced the depth of the milk layer. The viscosity of the cream was decreased. These effects were associated with precipitation of the calcium by heat.

An increase in the temperature of separation will decrease the depth of the milk layer and will decrease the body of the cream.   C.J.B.

294. How the Milk Market was Stabilized in Port Arthur, Texas. J. C. WATKINS, Port Arthur Chamber of Commerce, Port Arthur, Texas. Milk Dealer *26*, 4, p. 43, Jan., 1937.

The author points out that with milk retailing at five cents a quart in a market having two pasteurized milk distributors and some 60 producer-dis-

tributors, the outlook for the milk industry in Port Arthur five years ago was pretty dark. He then describes how cooperative action between producers, distributors, consumers, and the local chamber of commerce resulted in organization of the industry and price stabilization that has stood the time test of five years of successful operation.   C.J.B.

295. Do Your 1937 Consumers Know? J. H. FRANDSEN, Mass. State College, Amherst, Mass.   Milk Dealer *26*, 4, p. 44, Jan., 1937.

The author reviews the virtue of milk as a food and reminds the dairy industry that because of a new generation every year, they must continue to boost the extensive use of dairy products.   C.J.B.

296. Practical Laboratory Tests for Measuring Milk Quality. STANLEY W. WHITSON, Univ. of Nebraska.   Milk Dealer *26*, 4, p. 70, Jan., 1937.

The author discusses some of the advantages and disadvantages of such laboratory tests as the standard plate culture method, direct microscopic method, Frost little plate method, methylene blue reduction test, bromthymol blue test, bromcresol purple test, and the acidity test in determining milk quality.   C.J.B.

297. The Regulation and Control of Milk Supplies. S. V. LAYSON, Division of Sanitary Engineering, Ill. Dept. of Public Health.   Milk Dealer *26*, 5, p. 36, Feb., 1937.

A discussion of the development of milk regulations in Illinois. The author points out the major part which pasteurization is playing in developing a better milk supply. Evidence of the effectiveness of pasteurization is shown by the fact that there has not been a case nor an epidemic of milkborne disease in Illinois traced to pasteurized milk since health officials assumed charge of the sanitary supervision of down-state pasteurization plants in 1926, as compared to the fact that nearly each year raw milk has been responsible for illness and death.   C.J.B.

298. Bottle Washing Alkalies and Their Application in Milk Plants. HANS EDEL, Gehl's Guernsey Farms, Milwaukee, Wis.   Milk Dealer *26*, 5, p. 42, Feb., 1937.

The author discusses the importance of knowing the exact percentage of causticity in the soaking compartment of bottle-washing machines. Suggestions for maintaining the correct percentage of causticity are also given.
                C.J.B.

299. Place of the Standard Milk Ordinance in the Marketing of Milk. LEON BAUMAN, President, Kansas Association of Milk Sanitarians. Milk Dealer *26*, 5, p. 44, Feb., 1937.

A discussion of the Standard Milk Ordinance based on the essential

points to any good milk ordinance, as set forth in the report of the White House Conference of 1928 on Health, and on its application in the State of Alabama. C.J.B.

300. Current Trends in Milk Consumption—August-October, 1936. EDWARD FISHER BROWN, Milk Research Council, Inc., New York City. Milk Dealer *26*, 5, p. 47, Feb., 1937.

The author gives a comprehensive report of the performance of the fluid-milk market in metropolitan New York, Boston, and Philadelphia during the period August to October, 1936. C.J.B.

301. Refrigerated Retail Delivery Trucks. Milk Dealer *26*, 5, p. 48, Feb., 1937.

Description of a retail delivery truck in which a series of drawers, which may be sized so as to accommodate cases filled with bottles or to accommodate bottles only, is refrigerated. A considerable saving in the cost of refrigeration is claimed for this new type of delivery truck. C.J.B.

302. The Changing Picture of Fluid Milk Marketing. LELAND SPENCER, Cornell Univ., Ithaca, N. Y. Milk Dealer *26*, 5, p. 82, Feb., 1937.

A discussion of the developments which have considerably changed the situation and conditions with which fluid milk cooperatives have to deal is given. C.J.B.

303. Public Health Features in Milk Plant Layout. RALPH E. IRWIN, Bureau of Milk Sanitation, State Dept. of Health, Harrisburg, Pa. Am. J. Pub. Health *27*, 1, p. 37, 1937.

The regulations and plans presented in this article are for the purpose of obtaining compliance with Pennsylvania law. The main public health features are (1) a milk room protected from flies and located so that it cannot be used as a passageway, (2) equipment located so that every part is accessible for cleaning, (3) the processing of milk and the cleaning and filling of containers carried on in progressive steps without "back tracking" (4) a steam tight surface for walls and ceilings and ventilation to prevent condensation on walls and ceilings and (5) sanitary features that make it easy to handle milk and cleanse containers in a clean manner. M.W.Y.

304. The Use of Wooden Vessels for the Transportation of Milk. G. GENIN, Engineer E. P. C. Paris, France. Le Lait *16*, 158, p. 841, Sept.–Oct., 1936.

It was found that oak tanks painted with resistant paint could be used for the transportation of milk without odors or flavors from the container affecting the quality of the milk in any way. Many paints had to be studied to find those that would withstand the action of the milk and the dairy detergents used for cleaning. A.H.J.

305. Oxidized Flavor in Milk. II. The Effects of Homogenization, Agitation and Freezing of Milk on its Subsequent Susceptibility to Oxidized Flavor Development. L. M. THURSTON, W. CARSON BROWN AND R. B. DUSTMAN, West Va. Agr. Exp. Station, Morgantown, West Va. JOURNAL OF DAIRY SCIENCE *19*, 11, p. 671, Nov., 1936.

Homogenization, severe agitation, and partial freezing of milk all tended to reduce the tendency of milk to become oxidized in flavor.   A.C.D.

306. The Hygienic Control of Milk at Nancy. H. BAUDEAU, Veterinary Inspector, Nancy, France. Le Lait *16*, 159, p. 946, Nov., 1936.

In improving the milk supply for the city of Nancy, France, the following determinations were made: density, fat by the Gerber method, temperature, filtration, and organoleptic examination of the milk when received at the dairy, acidity, reductase test, catalase test, reactions of Schardinger, Dupouy, and Schern-Gorli, bacteria count, colon bacilli examination, and centrifugation and examination of the precipitate.   A.H.J.

307. Factors Affecting the Activatability of Milk with Ultra-Violet Light. W. E. KRAUSS, R. M. BETHKE, AND R. G. WASHBURN, Dept. Dairy and Animal Ind., Ohio Exp. Sta., Wooster, Ohio. JOURNAL OF DAIRY SCIENCE *19*, 12, p. 739, Dec., 1936.

It was found that the activatability of milk by irradiation increased directly with the fat content and was also affected by the breed of the cows which produced it.   A.C.D.

308. Cleaning Dairy Equipment with Trisodium Phosphate. L. A. ROGERS AND FRED R. EVANS, Bureau of Dairy Ind., U. S. Dept. of Agr., Washington, D. C. JOURNAL OF DAIRY SCIENCE *19*, 12, p. 733, Dec., 1936.

The use of trisodium phosphate with sodium chromate was found to be particularly efficacious in cleaning separators and milking machines.

A.C.D.

309. Oxidized Flavor in Milk. III. The Time of Copper Contamination During Production and Processing, and Aeration Versus no Aeration as Related to Oxidized Flavor Development. W. CARSON BROWN, L. M. THURSTON, AND R. B. DUSTMAN, West Va. Agr. Exp. Sta., Morgantown, West Va. JOURNAL OF DAIRY SCIENCE *19*, 12, p. 753, Dec., 1936.

The acceleration of the development of oxidized flavor in milk by copper was most pronounced when the copper was added to the milk after pasteurization.   A.C.D.

310. Amylase in Cow's Milk. G. A. RICHARDSON AND C. L. HANKINSON, Univ. of California, Davis, California. JOURNAL OF DAIRY SCIENCE *19*, 12, p. 761, Dec., 1936.

Milk contains both alpha and beta amylase, the former being inactivated at 55° C. for 30 minutes and the latter at 65° C. for 30 minutes.   A.C.D.

Other abstracts of interest are numbers 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 214, 216, 217, 218, 222, 223, 224, 225, 226, 227, 228, 230, 231, 232, 233, 234, 235, 239, 240, 250, 252, 254, 262, 311, 312, 313, 314, 315, 316, 317, and 318.

MISCELLANEOUS

311. Use of Rubber in the Dairy Industry. G. GENIN, Engineer E. P. C. Paris, France. Le Lait *16*, 153, p. 256, March, 1936.

The author discusses the use of rubber in the dairy industry.   A.H.J.

312. Where Do Consumer's Dollars Go? WILFORD L. WHITE, Chief Marketing Research Division, Bureau of Foreign and Domestic Commerce; Ice Cream Trade J. *32*, 10, p. 11, Oct., 1936.

The author states that we do not have enough data to know where the consumer's dollars go. With what information there is available, he has considered the question from three general points of view: (1) consumer changes, (2) consumer income, and (3) consumer expenditures.

The fundamental changes in buying habits and distribution methods and policies are being brought about by decrease in size of the family, increase in average age of the individual, redistribution graphically, stabilization in numbers and shift in occupations.

The income of a wage earner ranging from $1,300 to $1,600 for the year was spent as follows: 32 per cent for food and 74 per cent for food, clothing, and use of home.

The author also discusses the movement of consumer goods through distribution channels, allocation of expenses, location of consumers, and the family budget.   W.H.M.

313. Plant Engineering Problems in the Dairy Industry. BERNHARD O. OPITZ, Western Dairy Prod. Inc., Seattle, Washington. Ice Cream Trade J. *32*, 10, p. 25, Oct., 1936.

The author classified the engineering problems as: operation, equipment, and maintenance; and subdivided the latter into: condition of brine, motors, switches, wiring, pipe covering, steam and water valves, steam traps, reducing valves, pumps, and all other equipment.

A poor power factor can be improved by such devices as rotary condensers, static condensers, synchronous motors, or fully loaded induction motors. When the plant is large enough, a static condenser is advised.

Recommendations made were: lower temperatures require lower back pressures on the compressors, heavier insulation for hardening rooms, use of electric motors rather than steam driven motors. The use of "V" belt drive for compressors, continuous freezers, and cooling hardening room by circulating rather than dead air were suggested.   W.H.M.

314. Revamping Refrigerating Systems to Cut Down Cost of Power. HERMAN VETTER. Ice Cream Trade J. *33*, 2, p. 25, Feb., 1937.

Before any changes are made in a plant a thorough engineering analysis should be made. It is reasonable to expect a 20 per cent return on the added investment required to make the change. On basis of the amount of heat handled by a refrigeration system the condenser which handles 50 per cent is most important. The compressor handles 8.68 and the evaporator 41.31 per cent of the heat. Improvements are made when it is possible to increase efficiency, lower production costs or to increase capacity. The efficiency of a refrigeration system is dependent upon the proper balance between the three essential parts listed above. By increasing condensing surface, or additional evaporating surface, it is possible to effect savings in power requirements for compressors. Efficiency may also be raised by increasing the size of pipe lines and by the use of improved valves in the compressor. Remodeling existing equipment sometimes offers greater possibilities for increased efficiency than does the purchase of new equipment.

W.H.M.

315. The Use of Graphic Charts. STANLEY L. KEDZIERSKI, Bureau of Foreign and Domestic Commerce, U. S. Dept. of Commerce, Washington, D. C. Proc. 36th Ann. Conv. Intern. Assoc. of Ice Cream Mfgrs. *3*, p. 26, Oct., 1936.

Graphic methods are used for presenting all kinds of statistical data in visual form. The usefulness of graphs lies in the clearness of their interpretations. Graphs are essential because they save time and effort in analyzing data.

Graphs may be used liberally as part of a well developed statistical research department where a few pertinent facts are recorded. Generally graphs are used for internal control of an enterprise; an executive can directly compare external conditions with the state of his own business. The sales executive finds graphs invaluable in recording (a) customer activity, (b) results accomplished by his salesmen, and (c) trend of sales for any given period. The credit manager can use graphs to discern customer conditions, thus reducing to a minimum collection cost and bad debts. The production manager can use graphs to gauge his production schedule and thereby effect economy in operation costs.

The types of graphs are classified in this paper as (1) component series,

(2) spatial series, (3) time series, (4) frequency series, and (5) organization and control series. Examples of each type of graph are given and their usefulness is discussed.

Graphic forms should be selected according to their psychological appeal and ease of interpretation, the used for whom they are intended, and the purpose which they are designed to serve. The user must not allow himself to be carried away by the romance of graphic presentation, but must adopt methods in keeping with the degree of usefulness and the purpose which such presentation is designed to serve. M.J.M.

316. The Use of Statistics. WROE ALDERSON, Curtis Publishing Co., Philadelphia, Pa. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. 3, p. 57, Oct., 1936.

When judging statistical information, one should consider for what purpose the figures were obtained, what method was used in securing the figures, whether they are based on actual business or on estimates and whether they represent the average of a sufficiently large number of businesses.

The leading sources of statistical information are—

1. The United States Census Bureau.
2. Bureau of Foreign and Domestic Commerce.
3. Harvard Bureau of Business Research.
4. Dun and Bradstreet.
5. The Federal Trade Commission.
6. The Association of National Advertisers.
7. The Curtis Publishing Company.
8. Trade Association Statistics. M. J. M.

317. Training of Youth in Preparation for Taking Its Place in the Dairy Industry. H. F. JUDKINS, National Dairy Prod. Corp., New York, N. Y. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfgrs. 2, p. 144, Oct., 1936.

First, the requirements or needs of the dairy industry of its employees are set forth in this article; secondly, the means of measuring the qualifications of the employee; and thirdly, the responsibility of the dairy industry to the men it employs.

The discussion of the above phases of the question are based on the author's experience in personnel work. M.J.M.

318. Contemporaries of Martiny. Molkereizeitung, Hildesheim. 1936. with historic introduction by H. Weigmann.

The title of this book may convey no meaning to most American dairymen because they never heard of Benno Martiny who was born just 100 years ago, and who, in 1871, wrote a book on the dairy industry and

founded the first Dairy Journal, and spent all his life in the organization and promotion of dairy industry and dairy science. When Hermann Weigmann celebrated his 80th birthday a year ago, the Dairy Research Institute at Kiel, Germany, presented him with a collection of 100 portraits and biographies of the "Men around Martiny," men important in the history of dairying. This collection, enlarged to a total of 124, has now appeared in print.

The book is broad in its interpretation of dairying. It contains portraits of Leeuwenhoek, Pasteur, Robert Koch, Bang; it includes men famous for their work on animal feeding like Henneberg, Voeltz, Kellner, and Eckles, engineers like De Laval, editors of dairy papers, famous cheesemakers and professors, and leaders in the dairy industry like Bolle and Borden. The book is international in its aspects, but on account of the historic emphasis, only 5 Americans are mentioned, for the American dairy industry is young compared with that of Europe. Only 20 of the 124 men portrayed are still living, but the book begins with the year 1516.

<div style="text-align: right;">OTTO RAHN.</div>

JOURNAL OF DAIRY SCIENCE

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry

Milk Plant Monthly
Molkerei Zeitung

National Butter and Cheese Journal

Pacific Dairy Review

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Associatior of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

319. The Part of the Lactic Acid Streptococci in the Formation of Aroma in Starters. J. VAN BEYNUM AND J. W. PETTE. Report for 1935 of the Experimental Dairy Farm, Hoorn, Holland, pp. 205–235, 1936 (English summary)

The authors find that typical butter aroma is diacetyl produced by fermentation of citric acid by lactic streptococci and aromabetacocci.

Studies of *Streptococcus cremoris* and *Streptococcus lactis* for starters indicated that one organism did not give a distinct advantage over the other as excellent starters could be made with suitable strains of either bacterium in conjunction with aromabetacocci. This was substantiated by a study of 63 strains of lactic acid bacteria isolated from starters, sour milk, cheese, and whey.

Two new species were found, described, and named *Streptococcus aromaticus* and *Streptococcus citrophilus*.   A.C.D.

320. The Rydzewski Standard Loop Colony Count. GEORGE S. RYDZEWSKI, Blochowiak Dairy Co., Milwaukee, Wisconsin. Milk Dealer *26*, 6, p. 42, March, 1937.

The author describes a test which shows a direct relationship between the non-heat-resisting and heat-resisting bacteria. The test also tends to show the number of bacteria present in both raw and pasteurized milks, the percentage destruction by pasteurization, and the type and character of bacterial colonies.

The milk is measured and streaked on the surface of set agar in square petri dishes. As many as four samples may be streaked on one plate

                                                                        C.J.B.

BUTTER

321. A Study of the Body and Texture of Butter. S. T. COULTER AND W. B. COMBS, Dairy Div., Univ. of Minn., St. Paul, Minn. Minn. Agr. Exp. Sta. Tech. Bul. 115, Sept., 1936.

Data are presented showing the effect of variations in the manufacturing procedure on the hardness, spreadability, standing up properties, and appearance of butter as examined with a trier. The hardness of butter was found to be increased by cooling the cream to a low temperature, churning at a low temperature and using relatively warm wash water. The spreadability of butter was improved by the use of those practices which decreased the hardness of the butter. The standing up properties of butter were

increased by thorough cooling of the cream, churning at a low temperature and the use of wash water at a moderate temperature.

The authors recommend that winter butter be manufactured making use of those procedures which decrease the hardness of butter. Where these practices were followed, spreadability of the butter was much improved and a "sticky-crumbly" characteristic which is very common in butter produced during the winter in that locality was largely eliminated.

For the manufacture of summer butter the use of those practices which increase the hardness of butter is recommended.   S.T.C.

322. **Preventing "Sticky-Crumbly" Butter.** S. T. COULTER AND W. B. COMBS, Dairy Div., Univ. of Minn., St. Paul, Minn. Minn. Agr. Exp. Sta. Extension Folder 60, Feb., 1937.

A brief discussion of some of the practical aspects of the material presented in Minnesota Exp. Sta. Tech. Bul. 115, 1936.   S.T.C.

Other abstracts of interest are numbers 319, 326, 328, 364, and 365.

CHEESE

323. **The Cheese Yielding Capacity of Milk and Its Relation to the Method of Payment for Milk for Cheesemaking.** F. H. McDOWALL, Dairy Rsh. Inst., Palmerston North, N. Z., pp. 10364, 1936.

A satisfactory payment for milk must be based upon the percentages of butterfat and casein in milk. These may be determined by the Babcock and Walker Methods. Such systems of payment as fat, fat plus casein, fat plus 2, etc. are not correct as payment should be based on calculated cheese yields.

Cheese yields per hundred of milk vary not only with the fat and casein percentages but also with losses of fat in the whey, casein losses in the whey, ash, salt, and moisture content of the cheese. Shrinkage in storage and pasteurization of the milk which slightly increases the yield. The cheese yields, milk and cheese composition data were carefully determined at many New Zealand factories.

It was found that the Gerber tests made in the laboratory were .06 per cent higher than the Roese-Gottlieb results. The Babcock tests made in the factories were .045 per cent lower than the Gerber tests made in the laboratory.

The percentage of casein as determined by the Walker method agreed on an average with .016 per cent in the factory and the laboratory. The Walker tests were but slightly higher than those made by the A.O.A.C. method. The variations in calculated cheese yields due to analytical errors were considered.

The yield of cheese, when 14 days old, based upon Walker casein and the fat could be calculated by the equation:

yield per 100 lbs. milk = 2.08 C + 1.19 F

Using casein or total protein percentages as determined by A.O.A.C. methods, the equations were:

yield per 100 lbs. milk = 2.42 C + .98 F

yield per 100 lbs. milk = .167 P + 1.14 F

The cheese made for these trials, 785 vats of milk, contained 34.9 per cent water and 54.7 per cent of fat in the dry matter when 14 days old. The shrinkage during the first two weeks storage was 1.54 per cent of the weight of the green cheese.

The "casein plus fat" in milk and its relation to cheese yield was found to be:

(Walker), yield per 100 lbs. milk = 1.33 (C + F) + 1.42

(A.O.A.C.), yield per 100 lbs. milk = 1.20 (C + F) + 2.29

The fat/Walker casein ratio was 4.31/2 488 or .577. This ratio varied widely for individual vats of milk and increased during drought.

In conclusion the author recommends the payment for milk for cheese-making on the "costed cheese" system. The milk would need to be tested for casein by the Walker method (the only practical method) and for fat. Cheese yields would be calculated for each patron from the casein/fat ratio. Payment would be based upon the calculated cheese delivered and its value less cost of manufacture.   A.C.D.

324. Keeping Extraneous Matter Out of Cheese. J. W. Moore, Wis. Dept. of Agr. and Markets, State Capitol, Madison, Wis. Nat. Butter and Cheese J. *27*, 8, p. 12, April 25, 1936.

Twelve precautions are given to keep cheese free from extraneous matter.
                                      W.V.P.

325. Fermentations in Silage (A. I. V.) with Reference to Cheese Making. J. Van Beynum and J. W. Pette. Report for 1934 of the Experimental Dairy Farm, Hoorn, Holland, pp. 1–63, 1935 (English summary).

Butyric acid bacteria which were considered as a cause of gassy cheese and other abnormal fermentation were found in grass silage prepared by addition of mineral acids. The blowing of cheese was not always associated with large numbers of butyric acid bacteria.

It was found that the mineral acids were poorly mixed with the fodder and in the higher pH silage a lactic acid fermentation took place from the lactate-fermenting butyric acid bacteria, *Clostridium tyrobacterium*. This organism causes blowing in cheese. If the pH of the silage was 3.5, the sugar-fermenting butyric acid bacteria, *Clostridium saccharobutyricum*, predominates and it is not troublesome in cheese making.

It is suggested in making green forage silage that the pH should be

brought below 4 in all parts of the silage and that water be added to prevent respiration and activity of aerobic bacteria.   A.C.D.

Another abstract of interest is number 319.

CHEMISTRY

326. On the Estimation of Phospholipids in Milk and Milk Products.
B. J. HOLWERDA. Report for 1935 of the Experimental Dairy Farm, Hoorn, Holland, pp. 187–204, 1936 (English summary).

The contradictory data in the literature on phospholipids in milk and milk products was found to be due chiefly to a phosphoric ester in milk. It is extracted with fats and phospholipids, hence there is no direct quantitative method of determining phospholipids in milk.   The organic phosphorus should be determined in the alcohol-ether extract of both milk and its skimmilk, the difference between the two values being phospholipid phosphorus.

Most published data are 3 to 5 times too high, the actual values should be .7 and .8 milligram per 100 millimeters. The phospholipids are associated with the fat in milk but this is not true for buttermilk.   Fat free skimmilk is practically free from phospholipids.

A mono-amino phospholipid was isolated from milk, buttermilk, and the water phase of butter.   A.C.D.

327. The Effect of Freezing on the Physical and Microscopic Character of Gels of Corn and Wheat Starches. SYBIL WOODRUFF AND HENRIETTA HAYDEN.   J. Agr. Research *52*, 3, p. 233, Feb., 1936.

Starches prepared from three varieties of corn and one of wheat as nearly in their normal state as possible were used in making gels.   Cornstarch made a well formed gel in 5 per cent aqueous solution by heating to 75° to 80° C. (167.0° F.) but wheat starch did not until heated to 95° C. (203° F.).   The gels were frozen at −2° C. (28.4° F.) and also at the temperature of solid carbon dioxide.   In gross appearance the frozen gels were very different from the original ones.   The effect of freezing was greatest at −2° C. producing a sponge-like property in the gel.   The frozen gel absorbed water and water solutions of iodine or dyes whereas the original gel did not.

Photomicrographs are shown of gelatinized, frozen corn· and wheat starches.   Veined areas appeared in gels after slow freezing whereas fewer changes occurred in the gels frozen at the temperature of solid carbon dioxide.   L.M.T.

328. The Theroy of the Electrical Deacidification of Milk. JEAN PIEN AND JACQUES BAISSE. Lab. of the Farmers Union, Paris, France. Le Lait *16*, 159, p. 921, Nov., 1936.

A detailed study of the electrical deacidification of milk was made and it was concluded that lactic acid was not destroyed by the electrolysis. The electrolysis of a mixture of lactic acid and neutral salts resulted in no change in the acidity. In the presence of a protein, however, a deacidification resulted which may proceed as far as to render the solution alkaline. This phenomenon was a result of the blocking, by the protein, of the anion liberated by the electrolysis of salt. The cation neutralized the acidity of the solution. In the case of milk, the casein (and albumin) intervened in this sense and the anion fixed was particularly chloride originating from the electrolysis of chlorides. The sodium liberated at the cathode neutralized the lactic acid of the milk. The neutralized lactic acid was accounted for completely on analysis of the solution for lactates. The casein precipitated during the operation was found to contain considerable quantities of chloride. In the case of serum containing only a small content of protein, the electrolysis produced a certain amount of hypochlorite and neutralization was arrested due to lack of protein material. The electrical deacidification of a curdled milk was not possible because the precipitated casein did not react with the hypochlorite formed by electrolysis. There was a limit to the extent to which milk may be so deacidified by electrolysis (2.0 grams of lactic acid per liter of milk). This was determined largely by the chloride content of the milk. The experiments were conducted with platinum electrodes. When aluminum electrodes are used, milk may be deacidified to a greater extent because the aluminum originating from the electrode possesses neutralizing power for the lactic acid. The electrical deacidification was not considered a desirable method of treating milk as from the chemical, legal, or hygienic point of view it was equivalent to introducing into the milk soda or any alkaline product for reducing acidity. A.H.J.

329. Gelification of Casein in Relation with that of Milk. W. KOPAC-ZEWSKI. Le Lait *16*, 158, p. 801, Sept.–Oct., 1936.

Dispersions of casein in caustic soda solutions are caused to gel by the addition of different chemical substances in a different manner from that described in the scattered literature on the subject. The gelifying action of different substances is additive, thus to the gelifying power of an acid such as lactic must be added the gelifying power of such a base as sodium hydroxide when the lactic acid is added to the caustic soda dispersion of the casein. Certain salts accelerate the gelification of dispersions of casein by a base, by an acid or by a totally different substance. The phenomenon of gelification by a substance sometimes assumes a character of periodicity as a function of the concentration employed. This is the case with hydrochloric acid. Some of the gels undergo a syneresis more or less rapidly. This is the case with gels obtained by the action of caustic soda on the dispersions of the casein in the more dilute caustic solution. In other cases syneresis does not

occur even at the end of 2 months. The gels containing soluble calcium liquefy on standing. The addition to the dispersion of casein in dilute sodium hydroxide of either lactic acid or calcium chloride results in the formation of a white membrane around each drop of the added solution. These membranes are dispersed by agitation of the solution. The action of electrolytes incapable by themselves of causing caustic solutions of casein to gel is confusing, some retard gelification, others accelerate it, and others do not appear to influence it one way or another in the experimental quantities used, others depend for their effect on the quantities used. The following ions accelerate gelification: chloride, bromide, sulfate, ferricyanide and phosphate for the anions and magnesium, cadmium, lanthanum, cerium for the cations. The following ions retard gelification: barium, copper, iron, aluminum, and tin. Lead, uranium, and thorium are without action and iodide, bicarbonate and carbonate may reverse their action depending on the quantity. The substances known as anticoagulants for blood such as oxalates, fluorides, and the arsenobenzenes appear to have no antigelifying effect on casein under the conditions of the experiment.   A.H.J.

CONCENTRATED AND DRY MILK

Abstracts of interest are numbers 325, 326, 328, 329, 330, 336, 339, 360, 361, 363, 364, and 365.

FOOD VALUE

330. The Nutritive Value of Skimmilk Powders, with Special Reference to the Sensitivity of Milk Proteins to Heat. B. W. FAIRBANKS AND H. H. MITCHELL, Univ. of Illinois, Urbana. J. Agr. Research *51*, 12, p. 1107, 1935.

In this investigation the nutritive value of raw, liquid skimmilk was compared to that of four roller process powders and two spray process powders. All the skimmilk powders were obtained from one plant and from the same milk supply. The roller process powders used were: (1) Low temperature powder, produced at a steam gauge pressure of 50 pounds, (2) choice commercial powder produced at a steam gauge pressure of 87 pounds, (3) slightly scorched powder produced at a steam gauge pressure of 90 pounds with a thin film of milk on the drum, and (4) scorched powder produced at 90 pounds steam gauge pressure with the knives intermittently lifted from the rolls. One of the spray process powders was produced by the usual method, whereas the usual preheating was omitted from the process in manufacturing the other. The raw liquid skimmilk was obtained from the University of Illinois creamery.

Comparisons of the digestibility of energy, digestibility of protein, the net energy value and of the biological value of the proteins were carried out by feeding trials with white rats. The results show that the proteins of milk

are very sensitive to the intensities and durations of heat treatment employed in commercial drying. The digestibility of energy of the milk powders was reduced on the average 2.2 per cent as the result of drying. The digestibility of the proteins of skimmilk was reduced considerably by the roller process, especially when scorching occurred, and was slightly reduced in the spray process powder not preheated before drying but slightly increased in the spray powder when preheating before drying was employed. The various heat treatments did not affect the net energy value of the powders. As the temperature of drying in the roller process was increased until perceptible scorching occurred the biological value of the proteins was lowered rapidly. The first decline in biological value was attributed to destruction of cystine but further declines caused by more intense heat treatment were found to be the result of the destruction of lysine.   L.M.T.

331. Symposium on Vitamin D Ice Cream. Health and Nutrition Authorities. Editorial. Ice Cream Trade J. *31*, 4, p. 19, April, 1935.

No attempt is made to summarize the information collected. Replies to six questions asked seemed to indicate (1) that it has never been proven that ice cream reinforced with vitamin D is the best method of feeding vitamin D to infants requiring it, (2) that foods and materials other than ice cream should be used in supplying this vitamin, (3) that it has never been proven that adults need more vitamin D than is received in the ordinary diet, (4) that it has never been proved that ice cream is an effective antirachitic agent, and if it were it is not fed early enough in life to be of much benefit to children who might need it, (5) opinion was about equally divided regarding the advisability of fortifying ice cream with vitamin D, and (6) opinion was about equally divided on the advisability of reinforcement of food products with vitamin D.   W.H M.

332. Diabetic Ice Cream. Editorial. Ice Cream Rev. *20*, 6, p. 50, 1936.

It is estimated that at present there are 400,000 people in the United States afflicted with diabetes. This should offer an attracive market for a "diabetic ice cream." An example of success along this line is cited.
                    J.H.E.

ICE CREAM

333. Merchandising Through Contests and Premiums. Proc. 36th Ann. Conv. Intern. Assoc. Ice Cream Mfrs. *4*, p. 35, Oct., 1936.

A discussion led by Paul E. Reinhold, Foremost Dairies, Inc. Jacksonville, Fla.

Merchandising through premiums can be divided into three general classes. First, premiums to the consumer, second, premiums to the dealer, and third, premiums to the dispenser.

We have come to the conclusion that premiums to the consumer should be free goods of your own product. Premiums to the dealer were found to be of little help because the dealer does not come in contact with the ultimate consumer. However, premiums to the dispenser were found to be very profitable. By offering premiums to the dispensers, sales for the first month under this plan were more than double those of the same month of the preceding year.

(A) H. W. Brigham, Teall's Ice Cream Co., Rochester, N. Y.

This company offered 64 different premiums to boys and girls, each for a certain number of Eskimo Pie bags. The premium boards were prominently displayed in the dealer's store at the fountain. The main reason why this type of plan was adopted was because accumulating the bags stimulated a continuity of purchase.

Good premiums should be offered so as to stimulate interest. In our experience as many as 42 per cent of the bags were redeemed during some months, indicating great interest in the premiums. During the first year of the premium plan, the sale of Eskimo Pies per year increased from 450,000 to 3,000,000. Though premiums were not offered for the other items sold by the company, the sale of the other products advanced 15 to 25 per cent.

(B) L. A. Corning, Buttercup Ice Cream Co., Hamlet, N. C.

Our company has tried and is still using premiums; we believe free merchandise is the best type of premium. The sale of bulk ice cream increased 24.69 per cent and novelties 69.68 per cent, partly as a result of offering premiums. The increased business has affected favorably many cost figures, for example, delivery costs dropped 1 cent a gallon during the year.

(C) John H. Kloecker, Dixie Ice Cream Co., Lexington, Ky.

The author feels that premiums have a better possibility of producing sales than contests. He advocates that premiums be given often and immediately at the point of sale in one of the forms of the forms of the ice cream being sold rather than with other goods.

(D) Carl A. Steele, Steel-DeSoto Ice Cream Co., Minneapolis, Minn.

Merchandising through contests and premiums may produce a stimulating effect on sales which is only temporary. Furthermore, competitors with more liberal premiums may win away business which is won through premiums.

Eventually legislation outlawing this type of advertising may be passed. Eventually, the industry must make a fair analysis of costs, and once again put its products on the market with a fair margin of profit and a reasonable price to the consumer.   M.J.M.

334. Maintaining Refrigeration Equipment at the Peak Efficiency Level. JAMES M. KOVINO. Ice Cream Trade J. *30*, 6, p. 19, June, 1935.

The upkeep and maintenance of a refrigeration system divides itself into two phases: first, upkeep of mechanical and electrical machinery; and second, upkeep of the refrigerant itself.

The compressor is probably the most important mechanical piece of equipment and the best method of checking its efficiency is by means of an indicator. The oil used in the compressor is of prime importance in the efficiency of the equipment. Particular care should be given the oiling system of the stuffing box, and it should be watched carefully as it is a common source of trouble. The piston rod and cylinder walls also require attention if the compressor is to operate efficiently.

The principal thing to watch about the condenser is cleanliness. The tubes must be free from scale to permit rapid heat transfer. Foreign gases must be removed from a system if it is to operate efficiently. These may be removed through purging valves or on newer machines by a noncondensible gas separator.

Tools suitable for the machinery used should be kept on hand. Flow meters should be installed to check the amount of brine, water and ammonia pumped. The brine should be checked occasionally and kept strong enough to prevent freezing. The purity of the liquid ammonia should be checked occasionally by drawing a portion into a graduated cylinder and noting the amount that does not evaporate. W.H.M.

335. Compressing Hardened Ice Cream to Produce Uniform Density.
O. E. WILLIAMS, Research Lab., U. S. Bureau of Dairy Industry.
Ice Cream Trade J. *31*, 4, p. 31, April, 1935.

Most ice cream makers have at one time or another experienced difficulty in maintaining a standard or uniform density of their product. The author has devised a method of increasing the density of hardened ice cream by means of pressure. The process is designed to remove only the desired amount of air from the ice cream without melting it or increasing the size of the original crystal formation.

The value of such a process lies in the standardization of the product to a given density and the ease with which low density ice cream can be produced. The latter is especially true of some batch freezers where it is difficult to hold down the overrun.

The author has used three types of presses and found the hydraulic press to be most satisfactory. Ice cream with densities between 4.5 and 5 pounds per gallon at temperatures of 0 to 8° F. were easily compressed to 66 per cent of their original volume in both large and small cans. W.H.M.

336. Ice Cream with High Solids. A. C. DAHLBERG, N. Y. Agr. Exp. Sta., Geneva, N. Y. Ice Cream Trade J. *31*, 1, p. 30, Jan., 1935.

Recent years have seen a tendency toward the manufacture of high solids ice cream. There are two properties of milk solids-not-fat which have limited their use in building up solids in ice cream. They are: first, development of sandiness as a result of crystals, and second, the tendency for the production of a characteristic cooked or heated flavor. Methods are being

advanced to overcome these objections which consist chiefly of improved milk solids-not-fat with reduced lactose content or improved methods of incorporation in the mix.   W.H.M.

337. What's Wrong with Packaged Goods When It Reaches the Consumer? A. C. SCHRICKER, St. Louis Dairy Co., Missouri. Ice Cream Trade J. *31*, 1, p. 27, Jan., 1935.

In an effort to determine what is wrong with packaged goods when it reaches the consumer, the Research Committee of the Missouri Association of Ice Cream Manufacturers made a careful survey of the condition and flavor of packaged ice cream picked up at various points of sale.

The types of packages were studied in this survey. One was the Neapolitan or the three layer brick of vanilla, strawberry and chocolate. The other was a special flavor or combination of flavors which were put on the market irregularly.

The samples were scored as good, fair, and poor in regard to flavor; good, slightly coarse, and coarse in regard to texture; and as good or soiled in regard to package appearance. A summary of flavor rating of the Neapolitan packages with the percentages that scored as good are as follows: vanilla, 77.1 per cent; chocolate, 77.1 per cent, strawberry, 71.4 per cent. Percentages scoring as fair: vanilla, 14.3 per cent; chocolate, 11.45 per cent; strawberry, 17.4 per cent. Percentages scoring as poor: vanilla, 8.6 per cent; chocolate, 11.45 per cent; strawberry, 11.4 per cent. From this it is evident that the keeping quality of the package of ice cream is no better than that of the strawberry ice cream in it.

The special packages were scored as follows: good 81.5 per cent, fair 14.8 per cent, poor 3.7 per cent. The higher per cent of good flavors in this class of package is probably due to the fact that samples picked up were specials and the manufacturer is sure of a positive turnover before putting out another.

The percentages of the flavors ranking as coarse indicated that again the strawberry ice cream is the weak link. The special packages again show up better than the Neapolitan and probably because of the more rapid turnover.
                                                                W.H.M.

338. The Use of Sugars in Making Good Quality Ice Cream. P. S. LUCA, Michigan State College, East Lansing, Michigan. Ice Cream Trade J. *32*, 4, p. 34, April, 1936.

A discussion is presented on the importance of sugar as a source of solids in ice cream mix. Tables of data are given on the effect of sugar on the specific gravity of the mix, the freezing-point of the mix, the time required to reach maximum overrun, the per cent maximum overrun, and a table of scores for body and texture of ice cream containing various concentrations of sugar.

It was concluded that 15 per cent sugar so improved palatability and body as compared with lower percentages and is such a cheap source of solids that the advantages outweighed the disadvantages. It was further concluded that other sources of sweetening than sucrose are uneconomical unless used for purposes other than sweetening.　　　　W.H.M.

339. The Kniaseff Method for Finding the Fat Content of Ice Cream. D. H. NELSON, Dairy Industry Div., Univ. of Calif., Davis, Calif. Ice Cream Trade J. *22*, 11, p. 19, Nov., 1936.

A study was made to test the accuracy of the Kniaseff method of testing Various lots of mixes and frozen ice creams were tested by unskilled technicians and the results compared with those obtained by the Mojonnier method. When a 9 gram 50 per cent cream test bottle was used, 97.1 per cent of the unfrozen mix samples and 72.4 per cent of the frozen samples deviated .5 per cent or less from the Mojonnier test. When 18 gram 8 per cent whole milk test bottles were used, 84.4 per cent of the samples tested deviated from .3 to .5 per cent from the Mojonnier and 15.6 per cent deviated .2 per cent or less. Satisfactory results were also obtained on chocolate, strawberry and banana ice cream, ice milk and fresh chocolate milk drink. The method was not satisfactory for buttermilk. Accuracy and duplicability of the test suffered when 18 gram 50 per cent cream test bottles were used. Detailed directions for making the test are given.　　　　W.H.M.

340. When Consumers Talk Back. H. P. LONGSTAFF, Univ. of Minn., St. Paul, Minn. Ice Cream Trade J. *31*, 1, p. 13, Jan., 1935.

This article deals with the results of an ice cream consumer survey to determine their likes and dislikes. One hundred and forty-five consumers were interviewed by students in advanced advertising research at the University of Minnesota. Questions asked dealt with frequency of serving, preference for a home-made product, preference for dipped ice cream over factory filled packages, place of purchase, quantities purchased, and knowledge of food value. The answers to these and many other questions would be of value to ice cream manufacturers in analyzing the desires of their customers regarding ice cream.　　　　W.H.M.

341. Manufacture of Vanilla Ice Cream. C. C. TOTMAN, South Dakota State College, Brookings, South Dakota. Ice Cream Trade J. *31*, 2, p. 23, Feb., 1935.

The author discusses procurement, quality and storage of dairy products for ice cream, sources and amount of vanilla flavor, aging, freezing, and hardening of ice cream. A diagrammatic scheme showing the percentage of fat and total solids to use in a mix is presented.　　　　W.H.M.

342. Manufacture of Chocolate Ice Cream. W. H. MARTIN, Kansas State College, Manhattan, Kansas. Ice Cream Trade J. *31*, 3, p. 19, March, 1935.

Recommendations are given on the amount of chocolate flavoring material to be used in mixes of varying composition. Four formulae are also given for chocolate mixes together with directions on processing and freezing. Causes and remedies for various chocolate ice cream defects are discussed.

<div align="right">W.H.M. ·</div>

343. Manufacture of Strawberry Ice Cream. P. H. TRACY, Univ. of Illinois, Urbana, Ill. Ice Cream Trade J. *31*, 4, p. 15, April, 1935.

Four phases of the problem discussed are: proper selection of fruit and flavoring material, proper sanitary control, correct processing and correct merchandising.

The article includes a description of the methods used in the preparation of strawberry flavor, methods used in packing strawberries for use in ice cream, and the causes and remedies for the· stale, metallic flavor which frequently occurs in strawberry ice cream. Protection against copper contamination from equipment and rapid turnover in the plant and store are suggested as essential in the making and selling of a good product.

<div align="right">W.H.M.</div>

344. Manufacture of Fruit Ice Cream. W. C. COLE, Dairy Industry Div., Univ. of Calif., Davis, Calif. Ice Cream Trade J. *31*, 5, p. 17, May, 1935.

Five simple rules are given for the making of good fruit ice cream. They are: carefully select fruit, prepare it properly before adding to other ingredients, use enough fruit to justify the name, be sure that the fruit imparts the characteristic flavor desired, and lastly freeze the ice cream in such a way as to produce a smooth textured product and then serve it while fresh. <div align="right">W.H.M.</div>

345. Malted Milks Make Money. N. S. MACINTOSH. Ice Cream Trade J. *31*, 7, p. 13, July, 1935.

Directions are given for the making of several fountain malted milk drinks including frozen malted milk. Formulae and cost figures are also given for various items served at the soda fountain. <div align="right">W.H.M.</div>

346. A Book Review Delayed 105 Years. Editorial. Ice Cream Trade J. *31*, 7, p. 15, July, 1935.

This article is a review of a book, "The Art of Ice Cream Making" by Friedrich Goetz written in 1830. The review is continued in the August, 1935, issue of the Ice Cream Trade Journal giving a description of the art of making fancy forms. <div align="right">W.H.M.</div>

347. Here Is How to Use Stabilizers in Making Ices and Sherbets.
P. H. TRACY, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *31,*
7, p. 21, July, 1935.

The correct amount of gelatin to use can be determined in the following
manner:

1. Acidify water with citric acid so that it will correspond with the
acidity of the ice or sherbet to be made.
2. Dissolve 10 grams of the gelatin in 990 c.c. of the acidified water.
3. Heat the gelatin solution to 145° F. for 10 minutes and then cool to
about 60° F.
4. From the one per cent stock solution prepare solutions varying from
0.4 to 0.8 per cent. (using the acidified water) with .05 per cent intervals.
One hundred cubic centimeter graduates can be used for making up these
solutions.
5. Pour about 10 c.c. of the standardized solution into each of two tubes.
6. Place the tubes in a 40° F. bath for 18-24 hours.
7. Invert the tubes and select the one that will just stand inverted with-
out leaking for about 30 seconds.
8. Multiply the percentage of gelatin in the selected tube by the per-
centage of liquid in the gelatin or sherbet and divide by 100 The result
is the amount of gelatin needed.
Example:
   (a) Gelatin concentration in tube selected, 0.6 per cent
   (b) Percentage of liquid in sherbet $= 100 - [30$ (per cent sugar)$]$
         $+ [15 \times .4$ (per cent solids in mix used)$] = 74$
   (c) $\dfrac{.6 \times 74}{100} = .444 =$ percentage of gelatin needed.

Vegetable gums and pectin are also discussed and directions given for their
use. The discussion is continued (Ibid. 31, 7, p. 31) in which sherbet defects
are discussed and suggested formulae given.   W.H M.

348. The A B C of Making the Mix. H. A. ACKERMAN, Hydrox Corp.,
Chicago, Ill. Ice Cream Trade J. *31,* 7, p. 27, July, 1935.

The author describes the various phases of mix making, calling attention
to the importance of technical control, sources, ingredients for fat and
serum solids, amounts of serum solids, stabilizer and eggs to use, manner of
processing, homogenization pressures, pasteurization temperatures and
aging periods.   W.H.M.

349. The Dairy Scientists' Find. J. C. HENING, N. Y. State Agr. Exp.
Sta., Geneva, N. Y. Ice Cream Trade J. *31,* 8, p. 29, Aug., 1935.

This article contains a brief summary of the results of recent scientific
investigation in the field of ice cream making which were reported at the
13th annual meeting of the Dairy Science Association at the University of
Minnesota, June 24-27, 1935.   W.H.M.

350. The Year's Research Record.   A. C. DAHLBERG, N. Y. Agr. Exp. Sta., Geneva, N. Y.   Ice Cream Trade J. *31*, 10, p. 19, Oct., 1935.

The article reviews briefly some of the research work in the field of ice cream making, conducted by government, college and plant laboratories during the past year.   W.H.M.

351. Steel or Single Service Cans.   By Milk and Ice Cream Institute, Cleveland, Ohio.   Ice Cream Trade J. *32*, 4, p. 32, April, 1936.

The results of a survey of 1303 dealers indicated that 62.3 per cent prefer to handle ice cream in steel cans, 22.5 per cent prefer single service containers.   Figures are presented estimating the cost of using steel cans to be .0455, .0567, .0374, and .0303 cents per trip for plants of 100,000; 250,000; 500,000 and 1,000,000 gallons annual capacity respectively.   Single service containers make it possible to take care of dealers during the month of high production with a minimum investment in steel cans.   W.H.M.

352. The Dairy Scientists' Find.   A. C. DAHLBERG, N. Y. State Agr. Exp. Sta., Geneva, N. Y.   Ice Cream Trade J. *32*, 7, p. 23, July, 1936.

This article presents short reviews of the various papers pertaining to ice cream making which were presented at the 31st annual meeting of the American Dairy Science Association.   W.H.M.

353. Ice Cream Sales Index for 1936.   Special Bulletin No. 56, Intern. Assoc. Ice Cream Mfrs., 1105 Barr Bldg., Washington, D. C. April, 1937.

The bulletin contains an analysis of ice cream sales in 1936 compared with 1935 for the United States and Canada.   Each month in 1936 showed greater sales than in 1935, the average increase for the year for the United States being 22.26 per cent.   For Canada the year 1936 showed an increase in total sales of 13.88 per cent over 1935.   Business and weather conditions were both favorable for the ice cream industry during the year.

The data are also tabulated so as to show the sales index by states.   A condensed climatological summary of temperatures for each state is included as well as a summary of general business conditions for the year.

A supplement is contained in the bulletin which shows in graphic form ice cream and industrial production from 1929 to 1936, inclusive.   Ice cream sales in 1936 were nearer to the 1929 level than for any other year and were considerably above the 10-year average (1923–1932).

M.J.M.

354. Fighting Moisture in Ice Cream Bodies.   HARVEY LINDSAY, Pres., Dry-Zero Corp., Chicago, Ill.   Ice Cream Rev. *20*, 8, 1937.

Insulating material which takes up moisture is of little value.   In pre-

venting moisture absorption in truck bodies the first step is to provide a moisture seal between the insulation and outer air. Duplex waterproof kraft paper with edges sealed in hot asphalt is satisfactory for this purpose. The second step is to use insulating material that does not absorb moisture. The need for a properly vented inside liner in the truck body is discussed.

J.H.E.

355. Development of Oxidized Fat Flavors in Stored Frozen Cream and Ice Cream. H. H. SOMMER, Univ. of Wis., Madison, Wis. Ice Cream Rev. *20*, 7, p. 62, Feb., 1937.

The author comments upon and abstracts some of the recent work of Thurston and coworkers in which the view is advanced that lecithin in milk is probably the mother substance of the oxidized flavor rather than the milk fat. The author suggests the reader exercise caution and not to adopt this conclusion too irrevocably in the present development of the subject.

J.H.E.

356. Physical and Bacteriological Tests on Commercial Ice Cream Samples. H. H. SOMMER, Univ. of Wis., Madison, Wis. Ice Cream Rev. *20*, 6, p. 38, Jan., 1937.

At the annual convention of the Wisconsin Association of Ice Cream Manufacturers 21 manufacturers submitted samples of chocolate and vanilla ice cream for scoring and other observations. The bacterial counts are reported. They were generally low with only one sample exceeding a count of 100,000 colonies per gram. The pH of the vanilla samples ranged from 6.34 to 6.91. In the case of the chocolate ice cream the range was from 6.26 to 7.43.

Colors of the hardened ice cream samples were matched against the standard Lovibond tintometer slides. Considerable variation in color was noted among the samples.

The resistance of the ice cream to penetration was measured by means of the New York testing laboratory standard type penetrometer. There was quite a difference in resistance of the samples to penetration, but little correlation was obtained between penetration measurements and the melting behavior of the ice cream.

In the melting behavior of the samples there was exhibited extremely wide differences. The melt down ranged from a desirable creamy, non-foamy liquid, to samples which remained on the screen as a jelly-like foamy mass. J.H.E.

Other abstracts of interest are numbers 320, 326, 327, 328, 329, 330, 331, 332, 357, 359, 360, 362, 363, and 364.

MILK

357. Whipping Cream for Decorations and for Various Specialties. J. P. SMITH. Ice Cream Trade J. *31*, 2, p. 35, 1935.

For hand whipping select fresh sweet cream, testing 25 to 30 per cent butterfat, age 24 hours at 36° F. or lower, but avoid freezing, and add powdered sugar, flavor and color after cream is whipped. Gelatine, if used, should be dissolved (2 ounces in 1 pint of water), add one to one and one-half pounds of sugar to hot gelatine solution, chill until syrupy, then whip until fluffy and then combine it with 3 quarts of cream that have been previously whipped.

For mechanical whipping 20 to 25 per cent fat cream is preferable. Formula and directions are given for making commercially whipped cream and charlotte russe topping.

> 17 quarts 40 per cent fat cream
> 17 "   whole milk
> 8 pounds granulated sugar
> 9 ounces gelatine

Dissolve gelatine in 1½ quarts water and add sugar. Whip milk and cream at high speed until near ''breaking'' point, then whip at low speed, add hot gelatine and sugar slowly, and continue whipping just long enough to mix thoroughly.   W.H.M.

358. The Influence of the Age of Milk on the Sensibility to the Starch Reaction. JAROSLAV MASEK, The Inst. of Lactology of the Polytech. School, Prague, Tschecoslovacia. Le Lait *16*, 159, p. 941, Nov., 1936.

Milk that had been flash pasteurized at 88° C. (190.4° F.) gave a negative Storch reaction immediately after pasteurization while when held at room temperature, 17° C. (62.6° F.) for 24 hours, the same milk showed a tendency to give a positive Storch reaction. Some milk pasteurized in the same way but to which raw milk had been added in the ratio of 10 parts of pasteurized to 3 parts of raw milk initially gave a positive Storch reaction but after holding for 24 hours the reaction became negative. The addition of lactic acid to the milks so that the final acidity became 35° D (approximately .35% lactic acid) did not change their reaction to the Storch test.

                                                    A.H.J.

359. The Formation of Foam in Cream, Milk and Skimmilk. H. A. SIRKS. Report for 1935 of the Experimental Dairy Farm, Hoorn, Holland, pp. 1–60, 1936 (English summary).

In comparing maximum foam formation between 12° and 18° C. (53.6 and 64.4° F.) produced by churning sweet and sour skimmilk, it was found that more foam formed at the lower temperature. The reverse was true

when finely divided air was passed through the sour skimmilk. Similar results were secured by churning sweet or sour milk or cream. Blowing air through ripened cream gave greatest volumes at the lower temperature, the same as churning.

Maximum foam was secured by churning skimmilk at an acidity near the curdling point but the total volume was less than for sweet skimmilk. The churning time was influenced very slightly by acidification.

The maximum foaming produced by churning was rather uniform for sweet, ripened, raw, and pasteurized creams. In churning pasteurized cream the lessening of the volume was greater and the churning time shorter than for raw cream.

The addition of butter oil to skimmilk reduced the foam produced by churning, especially at higher temperatures and in acidified skimmilk.

Microscopic examination of the foam of ripened cream showed that a higher churning temperature which produced faster churning also produced smaller air cells. However, the total air surface was not increased as the volume was correspondingly less. A.C.D.

360. **Measurements of the Distribution of the Different Sized Fat Globules in Milk and Buttermilk.** II. A. SIRKS. Report for 1934 of the Experimental Dairy Farm, Hoorn, Holland, pp. 163–190, 1935 (English summary).

The number and the size of the fat globules in milk and buttermilk was accurately counted and measured. The problem is complicated for buttermilk as some fat globules were 80 microns in diameter. From the number and size of the fat globules and the specific gravity of the fat, the weight of the fat and its percentage in the milk and buttermilk was calculated.

It was found that results of microscopic examination and calculation agreed with the Gerber test of the milk but was far below the Gerber results for buttermilk. The author concludes that fat exists in buttermilk which is invisible microscopically. A.C.D.

361. **More About How the Milk Market Was Stabilized in Port Arthur, Texas.** J. C. WATKINS, Port Arthur Chamber of Commerce, Port Arthur, Texas. Milk Dealer *26*, 6, p. 46, March, 1937.

Additional information about stabilizing the milk market in Port Arthur, Texas, is given. The author summarizes the strong links in a cooperative organization as follows:

1. Voluntary association.
contract in any way.
2. Ability of the association itself to punish members who violate their
3. The power to obtain injunctions against further violations.
4. The unfaltering enforcement of the terms of the contract without a moment's delay, as soon as it is determined that a member has failed to keep his agreement in any particular. C.J.B.

362. The Effect of Homogenization on Some of the Characteristics of Milk Fat.   I. A. GOULD AND G. M. TROUT, Michigan State College. J. Agr. Research *52*, 1, p. 49, Jan., 1936.

Five trials were made with butter fats obtained in each trial by churning separated cream from each of four lots of milk handled as follows: Lot 1, pasteurized at 145° F. for 30 minutes; lot 2, pasteurized at 145° F. for 30 minutes and then homogenized at 1500 pounds pressure; lot 3, warmed to 100° F., homogenized at 1500 pounds pressure and immediately thereafter pasteurized; lot 4, homogenized at 100° F., cooled to 55° over a surface cooler, stored at 35 to 40° F. for 24 hours and then pasteurized.

No appreciable differences in the Reichert-Meissl number, Polensky number, refractive index or acid degree occurred in the fat when the pasteurized milk was homogenized.   However, when raw milk was homogenized, the acid degree of the fat increased four- to sixfold within a few minutes and about twentyfold after 24 hours storage   Homogenization of the raw milks did not cause any appreciable change in the Reichart-Meissl number, Polenski number or refractive index of the fat.

The authors conclude that the measurement of free fatty acids by titration of the fat appears to be a more accurate and more sensitive means of determining the rate of fat-splitting action than those determinations which may be made on the milk.

The results also included a verification of previous findings that the titratable acidity and hydrogen ion concentration of raw milk are increased in raw milk following homogenization.   L M.T.

Other abstracts of interest are numbers 320, 325, 326, 328, 329, 330, 331, 339, 355, 356, 363, and 364.

MISCELLANEOUS

363. Getting the Most Out of Steam.   F. J. VONACHEN, Troy Engine and. Machine Co., Troy, Pa.   Ice Cream Rev. *20*, 5, p. 26, 1936.

Steam can be made to do double duty by passing it through a prime mover and using the exhaust for heating and processing in place of live steam.   Specifications for modern steam engines are discussed.

J.H.E.

364. Reducing the Number of Accidents in Milk Plants.   Milk Dealer *26*, 6, p. 112, March, 1937.

Safe practices to prevent accidents at the various danger points in a milk plant are given.   C.J.B.

JOURNAL OF DAIRY SCIENCE

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

CONTENTS

PUBLICATIONS AND ABSTRACTORS

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

366. The Presence of Mastitis Streptococci in Bovine Mammary Tissue. G. J. HUCKER, N. Y. State Agr. Exp. Station, Geneva, N. Y. Conven. Intern. Assoc. Milk Dealers, Production Section, p. 87, 1936.

Udders of 23 cows which had passed through at least one lactation period and showed no traces of chronic mastitis were removed and handled aseptically. A member of the bovine mastitis streptococcus group was isolated from every udder. The conclusion is drawn that all cows which have passed through one or more lactation periods carry mastitis streptococci as a normal inhabitant of the udder. If the above conclusion is later confirmed then more emphasis will be placed upon individual resistance than upon eliminating actively infected cows from the herd. E.F.G.

367. Bang's Disease Control. L. J. THOMPKINS, Sheffield Farms Co., New York City. Conven. Intern. Assoc. Milk Dealers, Prod. Section, p. 99, 1936.

The successful use of calfhood vaccination for Bangs' disease is reported. E.F.G.

368. The Sterilization of Glassware. K. A. TRISH, Chief, Food and Sanitation, Dept. of Health, Kenosha, Wis. Ice Cream Trade J *33*, 4, p. 27, April, 1937.

A method was devised for checking the efficiency of the sterilization process used by restaurants and taverns. An ordinary test tube, containing a small, tightly wound cotton swab made on a wire the end of which extends through the cotton plug of the tube was used. To this tube 2 cc. of a normal saline solution was added and the tube and contents sterilized by autoclave for 20 minutes at 15 pounds pressure.

When collecting samples, the inspector removes the cotton plug, takes out the moist swab and carefully wipes the inner and outer rim of the cup or glass approximately one inch down, using a slow, gentle rotary motion and trying to cover the same amount of surface of each glass with the same number of strokes. The swab is then replaced in the tube and the tube gently shaken. Upon arrival at the laboratory, 1 cc. of the solution is plated out on nutrient agar, incubated for 48 hours and colonies counted. The elapsed time between collection and plating does not exceed two hours.

Two samples are collected at each establishment visited, and at the time the inspector notes any existing conditions which might affect the sterilizing process, checks the strength of chlorine solution, if chlorine is used, or the

temperature of rinse water where hot water is used. Establishments are rated on their bacterial counts, classifying those with counts of 1–10 as excellent; 11–30 as good; 31–50 as fair; 51–100 as poor; and over 100 as very poor.

Statistics covering a period from 1929 to 1937 were presented which indicated the number of establishments which were rated as good. Restaurants had a much higher percentage rate as good than did the taverns. High counts were usually traceable to an inadequate supply of hot water or improper strength chlorine rinse solution.   W.H.M.

369. Limitations of the Direct Microscopic Count of Bacteria in Milk. E. G. HASTINGS, Dept. of Agr. Bacteriology, Univ. of Wis. Milk Dealer *26*, 8, p. 100, May, 1937.

The author discusses the limitations of the direct microscopic count of bacteria in milk. It is pointed out that the method, while theoretically quite ideal, in reality has very distinct limitations and unless these are recognized, the judgment concerning the milks to which the method is applied is likely to be erroneous.   C.J.B.

BUTTER

370. Cooked Butter (Ghee). W. RITTER. Schweiz. Milchzeitung 12, 1936.

The writer discussed the manufacture of and the qualities of cooked butter (Ghee), which has become a general article of trade in Switzerland since about a year ago. The differences between cooked butter and butterfat obtained by mere separation from the aqueous parts at a low temperature are discussed. The latter does not present the aroma of cooked butter; it becomes colorless when heated and is less able to resist the development of tallowy flavor than cooked butter, which becomes slightly brown when heated. Probably the difference between these two kinds of butter rests in the fact that the cooked butter contains small amounts of lecithin. A slightly rancid taste or other undesirable tastes are removed by cooking the butter as housewives are wont to do for a long time (steam distillation). The mere separation of fat from aqueous parts at a low temperature has not the same effect.

The use of hydroquinone is discussed as an antioxidant against the development of tallowy flavor. A specific smell of fish-oil is produced by heating butterfat with certain amounts of hydroquinone at increased temperatures. A short mention is also made about the influence of copper and iron on the quality of Ghee, the antioxidizing effect of lecithin and the experiences made in controlling the quality of cooked butters offered for sale.   W.R.

371. Some Practical Procedures for Testing Sediment in Cream. S. L. TUCKEY, Univ. of Ill., Urbana, Ill. Nat. Butter and Cheese J. *27*, 10, p. 6, May 25, 1936.

Four proposed methods of testing for sediment in cream and butter were

submitted by the American Association of Creamery Butter Manufacturers in a national survey. Procedures are described and preliminary results from 31 laboratories are tabulated.   W.V.P.

372. How to Judge Butter. L. C. THOMSEN, Univ. of Wis., Madison, Wis. Nat. Butter and Cheese J. *27*, 10, p. 8, May 25, 1936.

Principles of butter judging and scoring are explained. Tables are given to show deductions for certain flavor and body defects.   W.V.P.

373. California's Shrinkage Problem with Mid-West Butter. F. ABBOTT, Sec'y. California Creamery Operators Association, Davis, California. Nat. Butter and Cheese J. *27*, 12, p. 18, June 25, 1936.

If leakiness of butter purchased by California distributors in middle western states is not eliminated, other sources of supply will have to be found.   W.V.P.

374. California's Butter Labeling Act—and Factors Leading to Its Adoption. FRED H. ABBOTT, Univ. of California, Davis. Calif. Nat. Butter and Cheese J. *27*, 23, p. 6, Dec. 10, 1936.

The Butter Labeling Act in California, which is the result of a quality improvement campaign, has resulted in a greater demand for first quality butter and better prices for producers of high-quality cream.   W.V.P.

375. How to Manufacture; How to Determine Butter of Good Keeping Qualities. J. A. NELSON, Montana State College, Bozeman, Montana. Nat. Butter and Cheese J. *27*, 23, p. 36, Dec. 10, 1936.

Keeping quality of butter depends on the cream, factory sanitation and manufacturing. It can be determined by scoring each churning of butter, holding a sample for 7 days at 70° F. and then rescoring.   W.V.P.

376. Factors Relating to the Keeping Quality of Butter. O. R. OVERMAN, Dept. of Dairy Husbandry, Univ. of Ill., Urbana, Ill. Nat. Butter and Cheese J. *27*, 24, p. 6, Dec. 25, 1936.

A summary is given of the results of a five-year study of the keeping quality of 36 lots of butter during a two-year storage period at 0° to −10° F. Records were kept of physical and chemical constants, rates of oxidation and methods of manufacture. The best keeping quality was found in unsalted butter churned from fresh cream separated from fresh, sweet, whole milk.   W.V.P.

377. Distribution and Costs of Steam, Electrical Power, and Labor in Representative Idaho Creameries. D. R. THEOPHILUS, HOBART BERESFORD, AND J. L. BARNHART. Depts. of Agr. Eng. and Dairy Husb.

Data secured in a detailed study of the distribution and costs of steam,

electrical power, and labor in two representative Idaho creameries established many interesting facts. Among the most salient facts were: Atmospheric roller driers used 65 to 80 per cent of the total steam generated; 1.4 pounds of steam were required to dry 1 pound of liquid milk; 8.8 pounds of steam were required to pasteurize 100 pounds of cream; straight-away can washers required more steam and power per 100 cans washed than rotatory washers; steam, electricity, and labor averaged respectively 28.3, 13.4, and 58.2 per cent of the total energy cost of manufacturing butter; steam, electricity, and labor averaged respectively 78.5, 9.1, and 12.3 per cent of the total energy cost of manufacturing milk powder; labor represented 70.9 per cent of the total energy cost of manufacturing ice cream.

<div align="right">D.H.N.</div>

CHEESE

378. Making Cheese from Pasteurized Milk. S. L. TUCKEY, Dept. of Dairy Husbandry, Univ. of Ill., Urbana, Ill. Nat. Butter and Cheese J. *27*, 23, p. 22, Dec. 10, 1936.

Pasteurization of milk for cheesemaking is discussed from the standpoints of health, cheese quality, industrial reaction, and manufacturing and economic problems.   W.V.P.

CHEMISTRY

379. Development of the Lactochrometer. H. H. TUCKER, N. J. Agr. Exp. Sta., New Brunswick, N. J. Conven. Intern. Assoc. Milk Dealers, Prod. Section, p. 42, 1936.

The depth of yellow color in milk is measured by measuring the depth of a layer of milk required to absorb an equal amount of blue and violet wave lengths as are absorbed by a standard plate. A reading of 10 is used when no milk remains for the light to pass through and a reading of 0 is used when 10 millimeters of milk are required.   E.F.G.

380. Testing Milk and Cream. D. H. NELSON. Circ. 340, California Agr. Exp. Station, 12 figs., 1937.

This circular describes the approved procedure for the simplest tests for the quality of milk and cream. With these directions the tests should be successfully performed by persons not familiar with milk testing or with laboratory technique. The tests described include the Babcock test for fat, the Mann's test for acidity, the lactometer method for solids, and the sediment test for extraneous matter.   D.H.N.

381. The Detection of Copper in Milk and Cream by Means of the Peroxydase-reaction. Schweiz. Milchzeitung 91, 1935.

It has been known for some time that the presence of copper in milk is apt to produce a positive Storch-reaction in high temperature pasteurized

milk, which may give the impression that pasteurization has not been sufficiently high. The author avails himself of this fact for the detection of copper in cream dissolved by keeping the milk in a kettle of copper before it is centrifuged. The formation of indo-phenol-dye by means of H_2O_2, dimethyl-p-phenylendiamin-sulphate and α-naphthol is recommended as a reaction fitted for the purpose. The cream must be shortly heated at 85° C., in order to kill the milk-enzyme. The reaction takes place after a period of 2 minutes up to 2 hours. It is weakened by a too high or a too prolonged heating. Experiments show the presence of copper in milk after one pumping or straining the latter through a brass sieve. The reaction does not take place in sour cream.

This way of detecting a cream that has come into contact with copper is easier and surer than the aldehyde-reductase (xanthine-oxidase) test or the tasting for tallowiness of the cream submitted to holding pasteurization and then cooled for 24 hours.   ·   W.R.

382. The Detection of Copper in Butter and Butterfat by Means of the Peroxydase-Reaction. W. RITTER. Schweiz. Milchzeitung No. 91, 1935.

A simple test for the detection of increased quantities of copper in butter and butterfat consists in heating at 85° C. and cooling again 2 grams of butter in 10 cc. of fresh milk which has not come into contact with copper. Afterwards the peroxydase-reaction with dimethyl-phenylendiamin-sulphate, α-naphthol and H_2O_2 is carried out with the emulsion. The presence of increased quantities of copper is shown by a quicker appearance of the blue coloring. The reaction is disturbed by the presence of somewhat important amounts of peroxides which are formed while tallowy flavor is developing in butter and other fats. The presence of · peroxide can be detected by carrying out the reaction with copper-salt instead of H_2O_2. This very simple reaction corresponds in its chemism to other rapid tests and is well adapted for determining the assimilation of copper by fats not yet spoiled.   W.R.

FOOD VALUE

383. The Nutritive Value of Milk. JOHN L. RICE, Comm. of Health, New York City. Abn. Conven. Intern. Assoc. Milk Dealers, Gen. Sessions, p. 69, 1936.

A summary of some of the outstanding nutritive qualities of milk.
                                                          E.F.G.

834. Milk Gains Recognition as Important Source of Vitamin C. Editorial. Milk Dealer *26*, 7, p. 49, April, 1937.

The National Dairy Council summarizes the work on pasteurization reported by Cornell University and Kansas State College. The following

points are of interest and importance to the dairy industry: (1) The vitamin C content of milk is relatively constant throughout the year, (2) it is commercially feasible to pasteurize milk by the holder method and maintain essentially as high a vitamin C content as that of raw milk at the same age.   C.J.B.

385. Chemical Sterilization on the Farm and in the Plant. F. E. A. SMITH, The Diversey Corp., Chicago, Illinois. Nat. Butter and Cheese J. *27*, 15, p. 34, Aug. 10, 1936.

Effective sterilization of dairy equipment with chlorine solution depends upon thorough cleaning of equipment; the use of proper amounts of solutions of correct strength; and upon complete contact of solution with equipment. Three general groups of chlorine sterilizers are described and directions for using them are given.   W.V.P.

386. Factors Involved in Making Milk More Palatable. JAMES MARSHALL FRAYER, Univ. of Vermont, Burlington, Vt. Milk Dealer *26*, 7, p. 42–, 98–, April, 1937.

A discussion is given of the factors affecting the flavor of milk. Abnormalities in milk classified according to their origin into five groups—(1) physiological disturbance, (2) feed, (3) bacterial, (4) chemical, and (5) absorbed—the author presents a complete review of the literature pertaining to each class.   C.J.B.

387. Fluid Milk Market Stabilization in Wisconsin. F. SCHULTHEISS, Comm., Wis. Dept. of Agr. and Markets. Milk Dealer *27*, 7, p. 44, April, 1937.

A detailed discussion and explanation of the Wisconsin fluid milk market stabilization law is presented.   C.J.B.

388. Current Trends in Milk Consumption; Nov. 1936—Jan. 1937. EDWARD FISHER BROWN, Milk Research Council, Inc., New York City. Milk Dealer, *27*, 7, p. 90, April, 1937.

The author gives a comprehensive report of the performance of the fluid-milk market in metropolitan New York, Boston, and Philadelphia during the period Nov., 1936, to Jan., 1937.   C.J.B.

389. The Significance of Bacterial and Chemical Changes Occurring in Mastitis Milk. L. A. BURKEY, E. B. MEIGS, G. P. SANDERS AND J. F. CONE, Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. Conven. Intern. Assoc. Milk Dealers, Prod. Section, p. 67, 1937.

It is believed that the percentage of chlorides, the presence of large numbers of the infecting organism and the loss of rennet curdling proper-

ties are the most significant changes helpful in the identification of mastitis through milk examination.

General observations upon attempts to experimentally induce mastitis through careless handling and rough milking practices indicate that the prevalence of high percentages of mastitis among dairy herds may be due as much to poor milkers and rough or extreme use of milking machines as to the spread of the infecting organisms. E.F.G.

390. Mastitis and Carbohydrate Deficiency. GEORGE W. CAVANAUGH, Cornell Univ., Ithaca, N. Y. Conven. Intern. Assoc. Milk Dealers, Prod. Section, p. 45, 1936.

That mastitis may be due to carbohydrate deficiency in the ration of the cow is suggested as a possibility by Fr. Wiedmann of the Research Institute of the Agricultural Control Station at Regensburg. Carbohydrate deficiency in the ration results in decreasing content of milk sugar and increasing content of sodium chloride in order to maintain normal osmotic pressure. With the salt rise the reaction changes and the germicidal property of the milk and udder disappears. A medium is formed that is most favorable for the growth of bacteria and mastitis develops because of decreased germicidal property. E.F.G.

391. Composition of Milk as Affected by Sub-clinical Mastitis. A. C. DAHLBERG, J. J. KUCERA, J. C. HENING, AND G. J. HUCKER, N. Y. Agr. Exp. Sta., Geneva, N. Y. Conven. Intern. Assoc. Milk Dealers, Prod. Section, p. 54, 1936.

It is concluded that the degree of infection of a herd with sub-clinical mastitis has no significant effect upon the composition of herd milk. Only when the infection becomes acute do changes of importance occur in the chemical composition of the milk. E.F.G.

392. Modern Merchandising—What Is It and How Does It Apply to the Milk Industry? RUSSEL J. DAVIS, Harrison, N. Y. Milk Dealer *26*, 8, p. 80, May, 1937.

The author insists that unless at least 50 per cent of the trade of any milk business can be attributed to the efforts of the routeman, the company is vulnerable to progressive competition. Ten ways to help the routeman are given. C.J.B.

393. Electric Sterilization of Dairy Utensils. J. M. BRANNON, Univ. of Ill., Urbana, Ill. Milk Dealer *26*, 8, p. 112, May, 1937.

Data are presented showing the energy consumed, bacterial counts per pail before and after sterilization, and the effect of the sterilized utensils on bacterial content of milk when using electric sterilization. The author concludes that the advantage the electric sterilizer has over other methods is convenience. C.J.B.

394. Some Factors Affecting the Properties of Whipping Cream and the Quality of the Finished Product. W. S. MUELLER, M. J. MACK, AND H. G. LINDQUIST, Dept. Dairy Industry, Mass. State College, Amherst, Mass. Mass. Agr. Exp. Sta., Bul. 335, Nov., 1936.

A mechanical whipper of constant speed was used for whipping the cream. Relative stiffness was determined by measuring with a sensitive wattmeter the input of the whipper motor in watts at intervals of five to ten seconds throughout the whipping process. The relative whipping ability of the cream was determined by comparing the average watt increase in stiffness per second of whipping time. Other properties studied were viscosity, overrun, and serum drainage.

Whipping temperatures above 40° F. for 36 per cent cream reduced the maximum stiffness and the overrun and increased the serum drainage of the whipped cream.

Cream separated from milk at 90° F. had slightly better whipping qualities than that separated at 100° F.

Standardizing cream, using skim milk or whole milk, whether before or after pasteurization gave no significant difference in the whipping ability of the resulting cream.

Pasteurizing cream at temperatures from 145° to 165° F. had little effect on whipping ability. Aging whipping cream longer than 24 hours had no practical advantages.

Cream containing 30 per cent butterfat is satisfactory for whipping.

Adding serum solids in the form of skim milk powder and plain condensed skim milk slightly decreased the whipping ability and serum drainage. The viscosity of the cream increased as the serum solids content was raised, and the plain condensed skim milk was more effective than the powdered skim milk in this respect. The benefits derived from increasing the serum solids content of 30 per cent fat cream to 11 per cent were not great enough to justify the procedure.

Adding 10 per cent cane sugar appeared to give sufficient sweetness to the whipped cream. Sugar up to 15 per cent may be added any time after the first minute of whipping without any detrimental effect. Adding sugar before pasteurization or immediately before whipping are the least desirable times for adding the sugar.

Homogenization at 500 to 1500 pounds pressure, running through a colloid mill, hand homogenizing, and delayed cooling of cream after pasteurization had no beneficial effects on the whipping ability of cream.

Partial freezing of milk (13 per cent) prior to separation and partial freezing of cream (50 per cent) either before or after pasteurization had no significant effect on the whipping qualities of the cream. Total freezing of cream after pasteurization was only slightly detrimental while total freezing of cream before pasteurization destroyed the whipping properties of the cream.

The use of Kraftogen, dehydrated sodium caseinate, Dariloid, gelatin, vegetable gelatin, dehydrated egg albumin and dehydrated egg yolk were studied and their effect on whipping cream is discussed, but since it is not legal in many places to use these substances the practice in general cannot be recommended. H.G.L.

395. The Trade-Ways Survey of Retail Salesmanship and Route Supervision in the Milk Industry. CARROLL Y. BELKNAP, Trade-Ways, Inc., New York City. Ann. Conven. Intern. Assoc. Milk Dealers, Sales and Advertising Section, p. 21, 1936.

Instances are cited to show the difference between effective and indifferent methods of selling milk by route salesmen. E.F.G.

396. Developing More Effective Salesmanship. ROBERT L. BUCKINGHAM, Trade-Ways, Inc., Chicago, Ill. Ann. Conven. Intern. Assoc. Milk Dealers, Sales and Advertising Section, p. 39, 1936.

Two points are covered: I. Route men can be made effective as salesmen; II. Route men need and want real selling help. The New I. A. M. D. training program and use of the manual will soon be available. E.F.G.

397. Quality Milk as a Sales Leader. STUART PEABODY, The Borden Co., New York City. Ann. Conven. Intern. Assoc. Milk Dealers, Sales and Advertising Section, p. 46, 1936.

An exceptionally high grade of milk, as certified, or some other premium milk will call attention to your product in a favorable manner and provide a distinctive selling point. E.F.G.

398. How a Well-Regulated Credit Division Can Assist Sales. A. J. CRAMER, Borden's Farm Prod., New York City. Ann. Conven. Intern. Assoc. Milk Dealers, Sales and Advertising Section, p. 62, 1936.

It is possible for the credit division to so handle many difficult accounts that these customers are retained and the accounts made profitable.

E.F.G.

399. How to Develop Selling Methods to Meet Changing Conditions. WILL A. FOSTER, Vice-President, Borden's Dairy Delivery Co., San Francisco, California. Ann. Conven. Intern. Assoc. Milk Dealers, Sales and Advertising Section, p. 82, 1937.

Changed dietary habits due to the machine age have presented problems for the milk industry. Selling methods are classified. E.F.G.

400. Between Meal Milk Service in Industry. ETHEL AUSTIN, Martin National Dairy Council, Chicago, Ill. Ann. Conven. Intern. Assoc. Milk Dealers, Sales and Advertising Section, p. 116, 1936.

A survey of 83 factories employing 115,000 persons in which more than,

½ had employed milk service for 10 years or longer showed an overwhelming sentiment in favor of the service. Methods of approach in order to initiate this service are discussed. Details of the service to make it most effective such as responsibility, method, time of day, products and safety measures are outlined.   E.F.G.

401. What the Milk Industry Is Doing to Build Consumer Confidence.
      F. J. KULLMAN, JR., Chairman, Public Relations Committee, I. A.
      M. D. Ann. Conven. Intern. Assoc. Milk Dealers, Gen. Sessions,
      p. 24, 1936.

The film, The Milk Parade, and the presentation of the Pasteur medals were emphasized.   E.F.G.

402. A Glimpse of the Dairy Industry Abroad Today. FRED F. LIN-
      INGER, Penn. State College, State College, Pa. Ann. Conven.
      Intern. Assoc. Milk Dealers, Gen. Sessions, p. 28, 1936.

Price control and consumer cooperatives in Great Britain, Sweden, Finland, Germany, and Russia are discussed.   E.F.G.

403. The Approach to and Results of 1936 Legislation. W. A. WENT-
      WORTH, Sec. Dairy Industry Committee, Washington, D. C. Ann.
      Conven. Intern. Assoc. Milk Dealers, Gen. Sessions, p. 43, 1937.

A summary of state and national legislation affecting the milk industry.
                                                                 E.F.G.

404. How Can Public Good-Will Be Safeguarded for the Dairy Industry.
      WILLIAM B. DURYEE, Secretary for Agr., State of New Jersey,
      Trenton. Ann. Conven. Intern. Assoc. Milk Dealers, Gen. Ses-
      sions, p. 59, 1936.

Numerous ways are discussed by which the milk industry can build consumer confidence and an appreciation of the value of the service which the modern milk distributor performs.   E.F.G.

405. Modern Merchandizing—Can Milk Dealers Do It. G. LYNN SUM-
      NER, Pres. G. Lynn Sumner Co.. New York City. Ann. Conven.
      Intern. Assoc. Milk Dealers, Gen. Sessions, p. 96, 1936.

The dairy industry with greatest single food and health product in the world is too modest. A discussion of the application of advertising to the milk industry.   E.F.G.

406. What We Saw at the Dairy Machinery Exhibit. E. N. MUZZY, Car-
      nation Co., Seattle, Washington. Ann. Conven. Intern. Assoc.
      Milk Dealers, Plant Section, p. 52, 1936.

The 1936 Dairy Industries Exposition Exhibits of new equipment are

discussed and described by the Messrs. Muzzy, Nourse, Goldsmith and Leudicke.   E.F.G.

407. Report of the Simplified Practice Committee. A. H. LEUDICKE, Chairman, Ann. Conven. Intern. Assoc. Milk Dealers, Plant Section, p. 81, 1936.

A report is made upon:

1. Tolerance for stainless steel tubing.
2. Sanitary fittings.
3. Flanged fittings.
4. Standardizing design of small cans.

E.F.G.

408. Treatment of Milk Wastes—American and European Practice. A. M. BUSWELL, Chief, Illinois State Water Survey, Urbana, Ill. Intern. Assoc. Milk Dealers, Plant Section, p. 107, 1936.

Dairy wastes are divided into 3 classes: (1) cooling water, (2) utensils and floor washing, and (3) by-products, as skim milk, buttermilk and whey. The use of trickling filters, activated sludge method and treatment of the waste in closed tanks under anaerobic conditions is discussed. The latter is recommended for class 3 wastes.   E.F.G.

409. Lowering the Milk Bottle Costs. R. B. SOLTZ, Ohio State University, Columbus, Ohio. Ann. Conven. Intern. Assoc. Milk Dealers, Plant Section, p. 113, 1936.

The plan operated by the Columbus Milk Dealers Assoc. by which the members of that Association obtained between 60 and 70 trips per bottle is described. This consisted essentially of preventing junk dealers handling milk bottles and educating the housewife as to the value of a milk bottle.   E.F.G.

410. Oxidative Changes in Milk, Cream and Butter. W. RITTER. Mitt. Lebensmitteluntersuchung and Hygiene *26*, p. 145, 1935.

Fishy and tallowy flavors of butter as well as the development of tallowy flavor in milk and cream under the influence of copper and iron are discussed. Allusion is made to the importance of heating and after-treatment of the milk and to the influence of antioxidants (hydroquinone, metol, ascorbic acid) and bacterial activity. Milk from certain cows can become tallowy without coming into contact with metals and the influence of copper, of holding pasteurization and of bacterial activity on the aldehyde-reductase (xanthine-oxidase) of cow's milk are discussed.   W.R.

411. The Influence of Copper and Bacterial Activity on the Aldehyde-Reductase (Xanthine-Oxidase) of the Milk. Landwirtschaftl. Jahrbuch der Schweiz, p. 873, 1935.

The aldehyde-reductase (xanthine-oxidase) of raw milk, as indicated by

the reduction time of a mixture of formaldehyde and methylene blue, is not essentially influenced by adding small amounts of copper in form of copper sulphates (up to 2 milligrams of copper for 1 liter of milk). The reduction time is not prolonged much by holding pasteurization. The influence of copper is somewhat intensified if this metal is added to milk after holding pasteurization. It is very strong if the copper is added to the milk before holding pasteurization is applied. Pieces of copper or copper-alloys (bronze, brass, German silver) produce similar reactions. If milk or cream are treated with bacteria before they are submitted to holding pasteurization in the presence of copper, the detrimental influence of the latter is considerably weakened. A certain parallel is established between the influence of copper on the aldehyde-reductase (xanthine-oxidase) and that on the development of tallowy flavor in milk; both influences being obstructed in a similar way by bacteria. Different conflicting phenomena make it possible to employ the reaction for the detection of traces of copper in milk or cream. The use of other aldehydes or coloring matters offers no advantage on that of formaldehyde and methylene blue.   W.R.

412. **Protecting a New Source of Profits for the Milk Dealer.** E. F.
    HRUBÝ, Eze-Orange Co., Chicago, Ill. Milk Dealer *26*, 8, p. 47,
    May, 1937.
    The author points out the necessity of concerted effort by milk dealers to fight those evils militating against their profit in the chocolate and fruit drink business.   C.J.B.

413. **History of Pasteurization.** JAMES A. TOBEY. Milk Dealer *26*, 8, p.
    52, May, 1937.
    A brief but detailed history of pasteurization is given.   C.J.B.

414. **A Dentist Looks at the Milk Business.** BION R. EAST. Milk Dealer
    26, 8, p. 74, May, 1937.
    Charts are presented showing the trend in per capita consumption of whole milk and cream with that for evaporating and condensed milk, for the year 1931 through 1935. The author concludes that present trends would seem to indicate that the whole-milk distributor must attempt to meet at least the nutritional claims of his evaporated competitor if he hopes to elude the shadows cast by decreasing whole-milk consumption.   C.J.B.

415. **Bulk, Packages and Novelties.** O'NEAL JOHNSON, Statistical and Ac-
    counting Bureau, Intern. Assoc. Ice Cream Mfgrs., Ice Cream
    Trade J. *33*, 4, p. 20, April, 1937.
    Reports from 300 plants representing 44,000,000 gallons of frozen products have been compiled. Sales trends during the ten year period 1925 to

1935 indicate a percentage decrease in the sale of bulk ice cream and an increase in the percentage sales of novelties and specialties, cups, and packages. Bulk sales decreased from 88.23 per cent in 1935 to 58.56 per cent in 1935. The sale of specialties in 1935 was over six times the amount sold in 1926, according to the Census Bureau report. Only one grade packaged ice cream was manufactured by 74.70 per cent of the plants and 16.87 per cent reported that they made two grades of packages. In regard to overrun 9.84 per cent reported overrun percentages greater in packages than bulk, 47.54 per cent reported the same overrun and 42.62 per cent reported a lower overrun in packages. Fifty-one per cent of the manufacturers sold packaged ice cream for a higher price than bulk, and the percentage selling it for the same price or a lower price was practically the same in both cases. Reasons for selling packaged ice cream were—because of competition, consumer demand, dealer demand, advertising possibilities, and to make possible the sale of two grades of ice cream. In the large cities the linerless direct fill brick package seemed to be the most popular type of package. Round cylinder type package was regarded as best for many manufacturers.

W.H.M.

416. Controlled or Dealer Outlets? C. O. KEENE, Miller Ice and Dairy, Cambridge City, Ind. Ice Cream Trade J. *33*, 4, p. 17, April, 1937.

Advice to the wholesaler of ice cream given by the author of this article is "make better salesmen and merchandisers of your accounts by teaching them how to make a good profit on ice cream sales and by teaching and working with them on store set-ups in order that a more desirable atmosphere will result. If your dealer is shown how he can make money on his ice cream and soda fountain sales, he will immediately give your merchandise the space and attention it deserves in his store and an immediate increase in volume will be your reward." To the operator of the various types of retail stores he says, "concentrate your efforts more in the operation of your store proper. Teach your clerks more about salesmanship and proper merchandising methods; devise some practical method by which leaks will immediately be detected; and demand that the gross you know can be had is in the cash register at the close of every business day." W.H.M.

417. The Trend in Trucking Costs. R. E. SLONAKER, Phila. Dairy Products Co., Inc., Philadelphia, Pa. Ice Cream Trade J. *33*, 4, p. 35, April, 1937.

The number of stops, gallons of ice cream sold, and the cost of delivery for 1932 and 1935, for three plants, each using a different type of delivery system, is given in the following table.

	Plant 1 Peddle System		Plant 3 Call System	
	1932	1935	1932	1935
Ave. No. of stops per route	39	36	61	58
Ave. No. gallons per route	68	74	232	210
Ave. No. miles driven	50.4	58.6	58.8	56.4
Cost of delivering per gallon	18.05	13.9	6.75	7.32

The type of delivery system used will depend on area served. The call system will work satisfactorily in the larger metropolitan areas and the peddle system seems better adapted to the smaller cities and towns.

The increase in packaged goods and novelties experienced by most plants has decreased the pay load and tended to increase trucking costs. On the other hand, mechanical cabinets have made it possible to increase the length of routes and cover more territory. Today a 1½ ton truck with mechanical refrigeration will carry as much pay load as a 5 ton truck would 10 or 15 years ago.

For all plants covered by this report the average number of gallons per route was 132 daily in 1932 and 161 in 1935. The 1932 delivery cost was 9.56 per gallon compared with 8.19 in 1935. Most of the saving was effected by change in the size and type of delivery equipment.   W.H.M.

418. Ice Cream Sales for 1936 Show Increase of 22.26 per cent over 1935. O'NEIL M. JOHNSON, Ice Cream Trade J. *33*, 5, p. 29, May, 1937.

Ice cream sales in every state of the union in 1936 were higher than for 1935. The increase ranged from 7.77 per cent in Kentucky to 46.00 per cent in Tennessee and an average of 22.26 per cent for the entire United States. These figures were based on reports received for members of the International Association of Ice Cream Manufacturers which represents more than half the total production reported by the Bureau of Agricultural Economics.
    W.H.M.

419. State Standards for Ice Cream—How Far Might They Go? HARRY KLUETER, Wisconsin Dept. of Agr. and Markets. Ice Cream Trade J. *33*, 5, p. 32, May, 1937.

The history and development of ice cream standards from the time of their inception up to the present time in the United States and in various states is described.   W.H.M.

420. Wedding Cakes for Blushing Brides in the Marry Month of June. P. J. Smith, Ice Cream Trade J. *33*, 5, p. 25, May, 1937.

Directions are given for making and decorating a simple and double tier ice cream cake.   W.H.M.

421. Ice Cream Regulation Must be Extended. R. G. Ross, Dept. of Health, Tulsa, Okla. Ice Cream Trade J. *33*, 5, p. 26, May, 1937.

Any ordinance covering ice cream or frozen desserts must be a part of or closely associated with a milk ordinance, as it would be impossible to enforce the former unless the latter was properly enforced.   W.H.M.

422. Milk Products in the Mix. P. H. Tracey, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *33*, 5, p. 27, May, 1937.

In a paper presented at the University of Illinois short course for ice cream makers the author has outlined the important points to be considered in the selection of the various milk products commonly used in the manufacture of ice cream.   W.H.M.

423. What Do Consumers Think? H. P. Smith, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *33*, 5, p. 35, May, 1937.

This paper deals with the information obtained from 200 customers of the University of Illinois milk route who were asked several questions pertaining to ice cream.   W.H.M.

424. Regulatory Standards and Methods of Manufacturing Ice Cream. William B. Palmer. Ice Cream Trade J. *33*, 5, p. 40, May, 1937.

Mr. Palmer, chairman of the Committee on Milk and Dairy Products of the American Public Health Association, discusses the recommendations made by his committee for the promotion of the work.   W.H.M.

425. Proper Processing of the Mix to Make Good Ice Cream. W. J. Corbett, Univ. of Illinois, Urbana, Ill. Ice Cream Trade J. *33*, 4, p. 29, April, 1937.

Directions are given for mixing and processing the ice cream mix. The importance of weighing ingredients, the order of adding the ingredients to the pasteurizer, neutralizing excess acid, pasteurization temperatures, homogenization and aging are some of the topics discussed.   W.H.M.

426. Using Fruits, Nuts, and Candy as Flavoring for Ice Cream. R. J. Ransey, Sealtest System Lab., Inc., Cleveland, Ohio. Ice Cream Trade J. *33*, 4, p. 37, April, 1937.

Recommendations are made regarding the amounts, varieties, and manner of adding various kinds of flavoring material to ice cream.   W.H.M.

427. Factors that Must Be Considered in Selecting the Mix Standard. P. H. Tracy, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *33*, 4, p. 38, April, 1937.

An analysis is given of the various factors which must be considered by the ice cream manufacturer in determining the composition of his ice cream.

In the selection of a formula consideration must be given to state regulations, the type of milk products and equipment available, the type of competition his ice cream must meet, the effect of the proposed combination of solids upon the quality and freezing operations, and the cost of the mix. Tables are presented to show the effect of texture score of ice cream made from mixes of varying fat and serum solid content, the relation of overrun to shrinkage in dipping, the relation of mix composition to the mix cost and the cost per gallon of mix for each of the solids used.   W.H.M.

428. Painting and the Elimination of Bacteria and Fungus. MILTON W. LIGHTCAP, Maintenance Service Dept., Pittsburgh Plate Glass Co., Pittsburgh, Pa. Nat. Butter and Cheese J. *27*, 10, p. 26, May 25, 1936.

Three essential steps must be taken to provide maximum sanitation in food manufacturing plants: abundance of light, absolute cleanliness, and the use of paint designed to inhibit growth of bacteria and fungi.   W.V.P.

429. Cutting Refrigeration Bills with Natural Cooling Without Ice. R. M. WASHBURN. Nat. Butter and Cheese J. *27*, 17, p. 6, Sept. 10, 1936.·

Methods of supplementing mechanical refrigeration in creameries with "natural cold" in winter are summarized. Fairly successful methods of cooling water for use in the plant include the use of an underground cistern in combination with a cooling tower; a system of pipes on the north side of the building for cooling water for the compressor; circulation of water through steel barrels; a series of sprays in outdoor tanks; and underground tanks far enough below the frost line to prevent freezing. The Washburn method uses the best features of the other systems and consists of a pre-cooler combined with a deep underground tank of three compartments.

W.V.P.

430. What Can An Association Accomplish for the Benefit of the Industry. WILLARD L. SIMMONS, Ice Cream Trade J. *33*, 5, p. 17, May, 1937.

The author discussed the activities of trade associations and their value to individual members.   W.H.M.

431. Data Compiled by the Census Bureau Record Changes in the Industry. Anonymous. Ice Cream Trade J. *33*, 5, p. 17, May, 1937.

The distribution of sales for 2,465 plants in 1935 and 3,150 plants in 1929 when compared show the trends and important changes which have occurred during this period. A decrease in the percentage of sales to their own wholesale branches, to industrial users, to wholesalers and jobbers, to

—

retailers, and to household consumers is indicated. Sales to their own retail stores increased from 4.7 per cent in 1929 to 10.7 in 1935.

Distribution expense amounted to 22.8 per cent of net sales, 9.8 per cent of which was for payrolls. Of the 13,119 employees 1,718 were females.

<div align="right">W.H.M.</div>

432. Getting the Most Effective Results from Plant Refrigeration Systems. L. C. THOMSEN, Univ. of Wisconsin, Madison, Wis. Ice Cream Trade J. *33*, 5, p. 23, May, 1937.

Information and data which should be helpful to prospective operators of refrigeration machinery are presented. Vertical single-acting machines are usually preferred by small to medium size dairy plants. These machines generally have a bore to stroke ratio of unity, *e.g.*, $4'' \times 4''$, $5'' \times 5''$, etc. By varying the speed intermediate capacities are readily attainable. Where large installations are necessary, the single- or double-acting horizontal machines have found favor. With this type of machine it is possible to operate at dissimlar suction pressures. In a plant where considerable low temperature work is desired, a two-stage machine may have a distinct advantage. These installations are usually found in plants with a rated capacity in excess of 50 tons. The rated tonnage of a compressor may be calculated by using the following equation:

$$\frac{\pi r^2 \times L \times N \times C \times V}{8.15 \times .42} = \text{Rated tonnage}$$

Where
$\pi = 3.1416$
$r = $ radius of cylinder, in feet
$L = $ length of stroke of piston, in feet
$N = $ number of strokes of piston per minute
$C = $ number of cylinders
$V = $ Volumetric efficiency in percentage

The vertical shell and tube type and the enclosed horizontal shell and tube type are increasing in popularity. Conservation of water may also be accomplished by passing the condenser water through the water jacket of the compressor and then used as boiler feed water. The unit type of cooler is becoming more popular for refrigeration room cooling. The finned type expansion coil is satisfactory although the air circulating unit type cooler with or without special circulating ducts is claimed to result in better temperature and humidity control as well as increased efficiency.

Other recommendations included are: the use of galvanized or rustless expansion piping, insulation of expansion lines, use of thermometers in expansion piping and condensers for the purpose of checking temperatures, and the correct installation of thermometers and gauges. Directions are also given for connection of the refrigeration line to direct expansion and continuous freezers and pressures used in the operation of this equipment. For the hardening room 9 to 12 linear inches of 2-inch diameter expansion

pipe will suffice for each cubic foot of space. Where it is desired to use the flooded system, the accumulator on the outside should be placed as high above the room as possible and its drain should be well insulated. In the flooded system 1 pound of ammonia per foot of 2-inch piping is required.

In the case of milk plants desiring to manufacture flake or brine ice, special machines have been built for this purpose.   W.H.M.

433. Are You Adequately Insured? CLARENCE T. HUBBARD. Ice Cream Trade J. *33*, 4, p. 25, April, 1937.

The centralization of insurance responsibilities for analysis and supervision with one competent source, and a review of all insurance contracts and problems periodically are recommended. A list of standard insurance available to ice cream manufacturers is given and important points to consider in the selection of insurance discussed.   W.H.M.

434.. The Necessity of Sound Accounting Methods under Present-Day Conditions. STUART C. MCLEOD, Sec. Nat. Assoc. of Cost Accounts, New York City. Ann. Conven. Intern. Assoc. Milk Dealers, Gen. Sessions, p. 64, 1936.

The application of accounting to the milk industry is discussed with particular reference to new developments including the Robinson-Patman Act and social security legislation.   E.F.G.

435. Generated vs. Purchased Power. RALPH COPP, Pevely Dairy Co., St. Louis, Mo. Ann. Conven. Intern. Assoc. Milk Dealers, Plant Section, p. 3, 1936.

Cost figures are given for plant investment and operation of Diesel and steam units operated under various conditions.   E.F.G.

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Milchwirtschaftliche Zeitung
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Milk Industry

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Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

436. B. W. Hammer Panegyric, by His Former Students. 1937, p. 250.
Published by the Collegiate Press, Inc., Ames, Iowa. Price $2.50.

This book was prepared by former students of B. W. Hammer as a tribute to him after 25 years of service at Iowa State College. The book is divided into two sections, the first one consists of 18 pages devoted to tributes to Dr. Hammer, and the second part consists of articles each written by a former student on various phases of the bacteriology and chemistry of dairy products. These individual articles deal principally with very recent investigations so that they are particularly valuable as giving new knowledge in the different subjects.

The best idea of the scope of the book may be obtained from a listing of the titles of chapters which are as follows:

Further observations on the quantitative changes in the microflora of cream and butter during manufacture, storage and shipment.

Churn contamination as a source of yeasts and molds in butter.

A comparison of media for determining the total bacterial count of butter.

Some observations on the yeast and mold count of salted butter made from sour cream.

The influence of filtration of inoculated wash water on bacterial count and keeping qualities of butter.

A method for the microscopic examination of butter.

The influence of starter on the flavor of butter.

The influence of various methods of neutralizing cream on the quality of fresh and stored butter.

A comparative study of Mississippi and Minnesota butter from the standpoints of certain fat constants and heat resistance.

The manufacture of high-scoring butter.

The effect of certain pencillia on the volatile acidity and the flavor of Iowa Blue cheese (Roquefort type).

Methods used to increase blue mold growth in cheese.

The effect of *Pencillium roqueforti* on some lower fatty acids.

The influence of certain bacteria on the ripening of cheddar cheese made from pasteurized milk.

Curing small units of American cheese in liquid paraffin.

A study of some of the physical changes involved in the rennet coagulation of milk and the subsequent firming of the curd.

Physical and chemical effects of homogenization of milk.

Distribution of bacteria in a quart bottle of whole milk held at 0° C.

Influence of growth temperature on the thermal resistance of some aerobic, spore-forming bacteria from evaporated milk.

The influence of growth temperature and age on the thermal resistance of milk cultures of *Streptococcus lactis*.

The limitations of significance of some of the methods of analyzing ice cream.

Studies on *Bacillus coagulans*.

Bacteria of the Escherichia-Aerobacter group in dairy products.

Observations on *Alcaligenes lipolyticus*.

Studies of lactobacillus cultures that actively coagulate milk.

Determination of acetylmethylcarbinol and diacetyl in dairy products.

A study of the distribution of strains of *Streptococcus lactis* which are sensitive to a filterable inhibitory principle from slow starters.   A.C.D.

437. Milk Examination. A Comparison of the Plate Count and Reductase Test. J. S. FAULDS. Lancet. *232*, p. 949, April 17, 1937.

To ascertain how far the results of the methylene-blue reductase test and the plate count are in agreement, the author examined 1500 samples by both methods.   He found that 22.3 per cent of the samples passed one test but not the other, the inconsistency being greatest in June and July during warm weather.   A total of 5.3 per cent passed the reductase test, but failed by the count and coli estimation, while 17 per cent passed the count and coli standard, but failed by the reduction test.   The discrepancy was greatest in milks of higher temperatures.   '

The author concludes that the methylene-blue reductase test is much simpler to apply than the plate count and yields 75 per cent of comparable results.   It is, on the whole, more stringent in warm weather and less stringent in cold weather.   Arguments in favor of the economy of this test are weak if the cost of collection is taken into account.   J.A.T.

438. Relation of Bovine Mastitis to Human Disease. PAUL B. BROOKS AND WALTER VON D. TIEDEMAN, N. Y. State Dept. of Health, Albany, N. Y.   Am. J. Pub. Health *27*, 4, p. 334, 1937.

The authors believe that the organisms responsible for cases of mastitis associated with outbreaks of septic sore throat and scarlet fever are always of human origin, *i.e.*, persons, usually milkers, with infected throats or occasionally wounds, even though it has not always been possible to find the individual.

The possible relation of mastitis to outbreaks of gastroenteritis and the evidence that organisms commonly present in mastitis may invade human tissues are discussed.   The general control of mastitis, if feasible, probably should be considered primarily an economic problem of the dairy industry since only occasional cases of mastitis are responsible for serious epidemics of disease.   Pasteurization destroys all of these organisms and probably their toxins as well, but when milk is being sold without pasteurization, all cases

of mastitis should be regarded as potentially dangerous and milk from any cow suffering from the disease carefully excluded. M.W.Y.

439. Control of Septic Sore Throat. G. J. HUCKER, N. Y. State Agr. Exp. Sta., Geneva, N. Y. Am. J. Pub. Health *27*, 4, p. 313, 1937.

Reasons for the difficulty in determining the true incidence of scarlet fever and septic sore throat in the United States are presented. Scarlet fever is primarily a contact disease while septic sore throat usually spreads from a common source of infection and not through contact. Septic sore throat in the main is traced to raw milk supplies. The cause and epidemiology of septic sore throat and the need for more reliable statistics on scarlet fever and septic sore throat infections are discussed. M.W.Y.

440. The Identification of Streptococcus of Mastitis in Routine Milk Samples. W. L. WILLIAMS, Univ. of Louisville, Louisville, Ky. Am. J. Pub. Health *27*, 5, p. 453, 1937.

An abstract of a paper read at the annual meeting in 1936. About 90 per cent of streptococcus strains causing bovine mastitis can be classed as *Streptococcus agalactiae*. Cultural characteristics are described for the strains which were isolated. M.W.Y.

441. Rapid Detection of B. Tuberculosis in Milk. MARY L. COWAN MAITLAND. Lancet 232, p. 1297, May 29, 1937.

A rapid method for direct microscopic examination of milk for tubercle bacilli has been tried on quarter samples from 950 cows and all results checked with the results of biological tests, except in one instance.

The procedure outlined is to spin the milk for 3 minutes at 2500 r.p.m., make a film from the deposit, dry in air and after half an hour fix with flame, cool, place in alcohol and ether (equal parts) for 15 minutes, wash with ether, stain with steaming carbol-fuchsin for 8 minutes, wash in water, decolorize in 3 per cent HCl in alcohol for 3 minutes, wash in water, decolorize in fresh acid-alcohol for 3 minutes, wash, counterstain with Löffler's methylene-blue for 2 minutes, wash well with water, dry, and examine under low power objective (⅔ in.) of microscope. J.A.T.

442. Report of Committee on Communical Diseases Affecting Man. JOHN G. HARDENBERGH, 23rd Ann. Report of Intern. Assoc. of Dairy and Milk Inspectors, Oct. 1934, p. 69.

This report covers statistical data on milk-borne diseases for 1933 and types of milk supply involved.

Factors necessary for a safe milk supply are discussed. L.H.B.

443. The Gas Requirements of Mold.—I. A Preliminary Report on the Gas Requirements of Pencillium Roqueforti (Various Strains of Blue Mold from Cheese). N. S. GOLDING, Div. of Dairy Hus-

bandry, Agr. Exp. Sta., State College of Washington, Pullman, Washington. JOURNAL OF DAIRY SCIENCE 20, 6, p. 319, June 1937.

The presence of carbon dioxide inhibited the growth of *Pencillium roqueforti*.   A.C.D.

BUTTER

444. Methods for Making and Significance of Cream and Butter Sediment Test. E. H. PARFITT, Dairy Dept., Purdue University, Lafayette, Indiana. Am. J. Pub. Health *27*, 4 p. 341, 1937.

Methods for determining sediment in cream and butter are outlined. The sediment in cream, like the sediment in milk, indicates carelessness on the part of the producer. Classification of sediment from butter is discussed.   M.W.Y.

445. A Modified Test for Salt in Butter. L. A. BRYANT, O A. C GUELPH. Can. Dairy and Ice Cream J. *16*, 6, p. 19, June 1937.

The author offers a modification of the standard salt test for butter In the modified test two drops of dichloro-fluorescein solution instead of two drops of potassium chromate indicator solution is added to the 25 cc. of salt solution. This indicator is recommended in place of potassium chromate since it gives a much sharper end point.   J.C.H.

446. Quantitative Determination of Lactic Acid in Butter. H. C. TROY AND PAUL F. SHARP, Cornell Univ., Agr., Exp. Sta, Ithaca, N. Y. Memoir 202, March 1937.

Three methods for the determination of lactic acid in butter were investigated. These methods all depend on the oxidation of lactic acid to acetaldehyde, the removal of the acetaldehyde from the oxidation mixture, the collection of the acetaldehyde in sodium-bisulfite solution, and the titration of the bound bisulfite with iodine. The methods differ in the amount of time required and the completeness of the removal of interfering substances.

Three procedures were studied. Troy and Sharp extraction method, Whittier and Trimble direct-oxidation method, and the direct-precipitation method. The last method is recommended.

It was found that after the butter is made, little increase in its lactic-acid content occurs when it is held even at fairly warm temperatures, and no increase at all occurs when it is held in cold storage.

The determination of lactic acid in butter serves as an indication of the lactic-acid content of the cream from which the butter was made, and is useful, therefore, in classifying butter on this basis. The lactic-acid contents of a number of samples of commercial butter are given.

The determination of lactic acid in the butter and in the buttermilk enables one to determine, by a simple calculation, the amount of buttermilk

remaining in the butter, and, from a knowledge of the water in the butter, to determine the efficiency of washing.

The determination of the lactic-acid content of the butter enables one to estimate the degree of souring of the cream from which the butter was made, and the determination of the pH indicates whether the cream was neutralized prior to churning.   E.S.G.

Other Abstracts of interest are numbers 436, 452, 453, and 455.

CHEESE

447. Cheese Mites and Their Control. G. G. DUNSTAN, O. A. C., GUELPH. Can. Dairy and Ice Cream J. *16*, 6, p. 26, June 1937.

This paper presents briefly the results of an interesting study of cheese mites, including species responsible, life history, nature of injury to cheese, method of distribution, conditions favoring mites and methods of control.

A study of fumigants has been made as one method of control. Requisites of a good fumigant for cheese and precautions in fumigation are given.

The author states, that, "Of the fumigants tested only two were found satisfactory: (a) methyl bromide 6.8 per cent plus carbon dioxide 93.2 per cent, and (b) ethylene oxide 1 part plus carbon dioxide 9 parts." J.C.H.

448. Wrappers for Processed Cheese. HUGH L. TEMPLETON AND H. H. SOMMER, Dept. Dairy Industry, Univ. of Wis., Madison, Wisconsin. JOURNAL OF DAIRY SCIENCE *20*, 5, p. 231, May 1937.

The various factors of importance in the selection of cheese wrappers are given and the data presented indicated tinfoil to be as satisfactory as any wrapper available now.   A.C.D.

449. The Microbiological Flora on the Surface of Limburger Cheeses. C. C. KELLY, N. Y. State Agr. Exp. Sta., Geneva, N. Y. JOURNAL DAIRY SCIENCE *20*, 5, p. 239, May 1937.

The bacterial flora of Limburger cheese were predominantly yeasts for several days and later was chiefly *Bacterium linens*.   A.C.D.

450. Observations on the Salting of Brick Cheese. E. L. BYERS AND WALTER V. PRICE, Univ. of Wis., Madison, Wisconsin. JOURNAL OF DAIRY SCIENCE *20*, 6, p. 307, June 1937.

Although salt penetrated quickly into brick cheese a uniform distribution was not secured for 8 weeks.   A.C.D.

Other Abstracts of interest are numbers 436, 438, 439, and 443.

CHEMISTRY

451. The Production of Milk of Abnormal Composition by Animals Free From Udder Streptococci. E. G. HASTINGS AND B. A. BEACH, Univ. of Wisconsin. J. Agr. Research *54*, 3, p. 199, 1937.

A herd of 31 one-year-old Holstein-Friesian heifers, free of tuberculosis and Bang's disease, was assembled on a farm on which there had been no cattle for 8 months and where the stables had been disinfected after removal of the previous herd.   The herd remained isolated from other animals except for the addition of a herd bull.   After the heifers freshened at about 2 years of age their milk was studied periodically for abnormalities which might indicate mastitis.   Three thousand samples of foremilk from separate quarters were analyzed for chlorine, catalase, and pH value.   Each sample was cultured on glucose agar and in milk.   Additional samples of foremilk and of the entire product of each quarter from animals producing abnormal milk were examined in greater detail as to composition and bacterial content.

The results show that on any periodic monthly examination from 4 to 16 of the heifers would have been adjudged as affected with chronic mastitis on the basis of the three criteria used.   However, no streptococci were found in any sample, the condition apparently being related to higher numbers of the usual types of bacteria found in the udder.   The observations did not indicate that the cause of the condition passes from animal to animal.   In some of the animals the abnormality in a quarter was present at the beginning of the lactation period and persisted throughout the period.   In other cases the abnormality appeared at some time during the lactation period and continued to the end thereof, and in still other cases it disappeared.   One or more samples of milk which satisfied the criteria of abnormality used, namely, a pH value above 6.8, a chlorine value above 0 15 per cent, and a catalase value in excess of 50 per cent, were obtained from 23 of the 31 cows. The detailed study of the records indicates that 17 of the animals may be considered as normal; 14 as abnormal.   L M.T.

452. The Higher Saturated Fatty Acids of Butter Fat. GEORGE E. HELZ AND A. W. BOSWORTH, Lab. of Physiol., Ohio State Univ., Columbus, Ohio. J. Biol. Chem. *116*, p. 203, 1936.

Extended fractionation of the methyl esters of the fatty acids from 360 pounds of butter was made to ascertain further the character of the fatty acids of high molecular weight.   The undistilled residue not distilling below 215° at 15 mm. was prepared and fractionated at 5 mm. pressure and up to 245°.   In these fractions was indicated presence of saturated acids from C_{18} (mol. wt. 284 4) to C_{24} (mol. wt. 368.5).   Presence of behemic acid in significant quantities was indicated.   In the residue not distilling below 245° was recovered hexacosanoic (cerotic) acid.   This crystallizes as nacreous crystalline plates from acetone and has a melting point of 80.5° C.   The methyl ester distills at 286° at 15 ± 0.1 mm. pressure and at 261° at 5 ± 0.1 mm. pressure.   The melting point of the methyl ester is 62°.   K.G.W.

453. The Carotene of Milk Fat (Butter). A. E. GILLAM AND M. S. EL RIDI, Chemistry Dept., Victoria Univ., Manchester, England. Biochem. J. *31,* p. 251, 1937.

With the discovery that carotene possesses growth promoting property (vitamin A activity) its presence in butter became important from a nutritional aspect, while later discovery that the pigment occurs in several isomeric forms having different vitamin A activities at once raised question as to which form was present in butterfat. The small amount of carotene in butter (0.2–2.0 mg. per 100 g. of fat) has made its isolation and examination difficult. In this investigation analytically pure butter carotene has been isolated from a mixed sample of colostrum and ordinary milk fat, and shown by analysis, m.p., absorption spectra and optical rotation to be pure beta carotene. The data show that for the sample of fat examined, alpha carotene is either absent, or is present in negligibly small amounts (less than 0.3 per cent of the total carotene). K.G.W.

454. The Determination of Galactose by the Method of Hagedorn and Jensen. ERNEST F. GALE, Biochem. Lab., Cambridge, England. Biochem J. *31,* p. 234, 1937.

A method is described for the estimation of amounts of galactose between 0.1 and 0.4 mg. The method is not reliable for lesser amounts. Bacteria of fermentation mixtures are coagulated by heating with zinc sulphate solution and are filtered off before the estimation of the sugar. The method applies the procedure involving reduction of ferricyanide by sugar, the excess ferricyanide being estimated iodometrically. K.G.W.

455. The Oxidation of Butterfat. II. The Composition of the Fat in Relation to Its Susceptibility Toward Oxidation. V. C. STEBNITZ AND H. H. SOMMER, Dept. of Dairy Industry, Univ. of Wis., Madison, Wisconsin. JOURNAL OF DAIRY SCIENCE *20,* 5, p. 265, May 1937.

Among other conditions it was stated that it is linoleic rather than oleic acid in butter fat which governs the rate of oxidation. A.C.D.

456. Lipaemia and Milk Fat Secretion in the Ruminant. FRANCIS X. AYLWARD, JANET H. BLACKWOOD AND JAMES A. SMITH. Hannah Dairy Research Inst. Kirkland, Ayr. Scotland. Biochem. J. *31,* 30, 1937.

Iodized fats, the proprietary names of which were "Radiopol" and "Lipiodol," were fed cows in an experiment designed to elucidate (1) the existence and nature of alimentary lipaemia in the bovine, (2) the rate at which fatty acids fed as glycerides enter the blood lipins and their relative distribution therein; and (3) the existence of a relationship between the level of a particular fatty acid in the blood and its secretion in the milk.

Fatty acids of the diet passed into the fat components of the blood enriching them in accordance with the composition of the dietary fat itself, the whole process following the course of a smooth lipaemia curve attaining a maximum in the case of the ruminant in 2 days and returning almost to normal at about the 5th day. For the iodized fat administered in the experiments, the amount secreted in the milk appears to be directly related to the amount in the blood. The proportion of the dietary fat carried in the blood as phosphatide was observed to be less than that carried as non-phosphatide, from which it would appear probable that phosphatide is not the chief means of transport in the blood, nor is it the precursor of milk fat, the latter rôle appearing to belong either to the glycerides or the cholesterol esters or both.   K.G.W.

CONCENTRATED AND DRY MILK

Abstracts of interest are numbers 436, 437, 451, 457, 458, 460, 472, 473, 475, 476, and 477.

FOOD VALUE

457. Prophylaxis of Rickets in Infants with Irradiated Evaporated Milk.
J. T. DAVIDSON, K. K. MERRITT, AND S. S. CHIPMAN. Am. J. Diseases of Children *53*, 1, p. 1, 1937.

Eighteen premature and fifteen full term infants were given irradiated evaporated milk during the first six months of life to determine degree of protection afforded.

Judged by roentgenograms, none of the premature infants was entirely free from rickets, six showed slight rickets, nine showed moderate rickets and three showed marked rickets.

Full term infants, with one exception, were almost completely protected against all but the slightest roentgenologic rickets. This was in marked contrast to the more severe degree of rickets observed in the rapidly growing premature infants.   W.H.R.

458. Comparison of the Anti-Rachitic Effects on Human Beings of Vitamin D from Different Sources. T. G. H. DRAKE. Am. J. Diseases of Children *53*, 3, p. 754, 1934.

No evidence was obtained of any difference in the antirachitic effectiveness in infants, rat unit for rat unit, of vitamin D administered in the form of cod-liver oil, of percomorph liver oil (a mixture of fish liver oils of high potency), of irradiated cholesterol, of irradiated fresh milk or of irradiated evaporated milk.   W.H.R.

459. A Demand for Action. Editorial. Lancet *231*, p. 824, April 3, 1937.

"That underconsumption of a foodstuff so important as milk should exist in a country so eminently suited for milk production, is a matter towards which we cannot remain indifferent," is one of the conclusions of the Ad-

visory Committee on Nutrition of the Ministry of Health of Great Britain, which has recently issued a preliminary report.

The committee states that consumption of milk in Great Britain is now less than one-half the optimum of seven-eighths of a pint per person per day, and they "deplore the fact that, while the volume of milk offered for sale is growing and there is a substantial surplus which it is beyond the capacity of the liquid milk market to absorb, there should be at the same time a severe deficiency of milk in large sections of the population." J.A.T.

460. The Value of Vitamin D Milks to the Consumer. JOHN W. M. BUNKER AND ROBERT S. HARRIS, 23rd Ann. Report of Intern. Assoc. Dairy and Milk Inspectors. p. 139, Oct. 1934.

This paper gives a very comprehensive review of literature on the subject of vitamin D milks.

A summary of clinical reports on vitamin D milks to October, 1934, is included.

The author concludes as follows: (1) That vitamin D milk has proved useful in the diets of infants and their mothers.

(2) That its use has apparently not had any undesirable effects.

(3) The exact antirachitic potency of such milks, which would be most desirable, has not as yet been determined.

(4) It has not yet been determined just what value vitamin D milk would have over ordinary milk for normal adults. L.H.B.

461. Nutritive Value of Chocolate Flavored Milk. W. S. MUELLER AND W. S. RITCHIE, Dept. of Dairy Industry and Dept. of Chemistry, Mass. State College, Amherst, Mass. JOURNAL OF DAIRY SCIENCE *20*, 6, p. 359, June 1937.

When the diet of rats contained more than $2\frac{1}{2}$ per cent cocoa there was a definite retardation of the growth rate. A.C.D.

ICE CREAM

462. The Relationship Between Temperature and Overrun in the Whipping of Ice Cream Mixes. ALAN LEIGHTON AND ABRAHAM LEVITON, Div. of Res. Lab., Bureau of Dairy Ind., U. S. Dept. of Agr., Washington, D. C. JOURNAL OF DAIRY SCIENCE *20*, 6, p. 371, June 1937.

An algebraic equation was derived to show the relation between overrun and drawing temperature of ice cream. A.C.D.

Other abstracts of interest are numbers 436, 437, 439, 442, 444, 446, 452, 453, 455, 457, 458, 460, 461, 463, 465, 466, 467, 468, 472, 473, 475, 476, and 477.

MILK

463. A New Method in Figuring Standardization of Cream and Milk. HANS EDEL, Gehl's Guernsey Farms, Milwaukee, Wis. Milk Dealer *26*, 8, p. 40, May 1937.

The author presents a method in figuring standardization of cream and milk by the use of charts. Advantages claimed for the method other than that it serves calculations are that the results are obtained in gallons and that the weights per gallon for the different percentages of fat in the cream are automatically taken into consideration. C.J.B.

464. One Hundred Per Cent Paper Container Operation. Milk Dealer *26*, 8, p. 42, May 1937.

A brief description is given of the Risdon Plant of Detroit which delivers wholesale only and operates 100 per cent with paper containers. C.J.B.

465. Effecting Sterilization by Radiation. A. R. DENNINGTON, (Westinghouse Lamp Co., Bloomfield, N. Y.) Can. Dairy and Ice Cream J. *16*, 6, p. 32, June 1937.

A discussion is given of a wide field for possible application of the use of short wave lengths for sterilization. It is reported that the experimental radiation of milk in a thin film for 40 seconds at a temperature of 35° F. gave about 98 per cent sterility without changing its flavor. J.C.H.

466. Report of Committee on Dairy and Milk Plant Equipment. WALTER D. TIEDEMAN, 23rd Ann. Report of Intern. Assoc. of Dairy and Milk Inspectors, Oct. 1934, p. 23.

This report gives a draft of tentative specifications for outlet valves to pasteurizers or holders, and for inlet connections to pasteurizers or holders. L.H.B.

467. Official Control of Pasteurization in Massachusetts. HERMAN C. LYTHGOE, 23rd Ann. Report of Intern. Assoc. of Dairy and Milk Inspectors, p. 81, Oct. 1934.

A report of the quality of the milk in Massachusetts during 1933 and 1934 both before and after pasteurizing is given.

A summary of violations found on inspection and of court cases are included. L.H.B.

468. Pasteurization and the Courts. JAMES A. TOBEY, 23rd Ann. Report of Intern. Assoc. of Dairy and Milk Inspectors, p. 109, Oct. 1934.

A review of court cases concerning pasteurization.

From the decisions cited it may be concluded that the judiciary realize that pasteurization is a reasonable measure required to aid in the insurance of a safe milk supply. L.H.B.

469. Certified Milk—Pasteurized. RICHARD S. EUSTIS, 23rd Ann. Report of Intern. Assoc. of Dairy and Milk Inspectors, p. 121, Oct. 1934.

Certified milk pasteurized was first recognized in Boston, Massachusetts, in 1928. During that year about 9 per cent of the total sales of certified milk was pasteurized. During the first half of 1934, 60 per cent of the total sales of certified milk was pasteurized.

Pasteurization of the certified milk has resulted in no change in flavor but the bacteria counts have been lowered.

During the five year period 92 per cent of the bacteria counts on the pasteurized certified milk were 100 or under.

The milk is pasteurized at the farm under supervision of the milk commission.

Vitamin D certified milk was undertaken in 1932 by encouraging the producers to feed irradiated yeast. The increase in the total sales of certified milk both raw and pasteurized since 1933 are attributed to the increasing demand for vitamin D milk.   L.H.B.

470. Milk Sanitation in European Countries. ROBERT S. BREED, 23rd Ann. Report of Intern. Assoc. Dairy and Milk Inspectors. p. 164, Oct. 1934.

Improvements in milk sanitation are taking place in all European countries. The greatest advances in milk sanitation are occurring in Great Britain and Italy. The custom of boiling milk in the home is practiced almost universally on the continent so that there has been little development in modern pasteurizing plants.   L.H.B.

471. Body of Cultured Cream. E. S. GUTHRIE, Cornell Univ., Agr. Exp. Sta., Ithaca, N. Y. Bul. 666, Feb. 1937.

Pasteurization temperatures near 165° F., with a holding period of 30 minutes, gave the smoothest, driest, and most viscous body of cultured cream.

Homogenization pressures of approximately 3000 pounds to the square inch resulted in the smoothest, driest, and most viscous body. The homogenization temperatures that gave the best results ranged from 165° F. down to 145°, depending on the desired thickness of body. Rehomogenizing at pasteurizing temperatures, or a few degrees below, increased the firmness, dryness, and viscosity of the body.

. The raising of the milk-solids-not-fat, by the addition of skimmilk powder, distinctly increased the viscosity and did not affect the texture of the body.

The use of rennet makes a firmer and more viscous body than is obtained when rennet is not employed. Its adaptability is limited by regulations of boards of health.

Gelatin produced a body that lost moisture, which is very undesirable. The viscosity was noticeably increased; the texture, however, was lumpy.

A ropy starter had little effect on the viscosity of the final product.

Increased milkfat above 18 per cent resulted in decreased viscosity.

A maintained ratio of solids-not-fat to fat in cream testing from 18 to 24 per cent of milkfat, gave a body of uniform viscosity.   E.S.G.

472. The Effect of Homogenization at Different Temperatures on Some of the Physical Properties of Milk and Cream. RANDALL WHITAKER AND L. D. HILKER, Res. Lab. of Sealtest System Lab., Baltimore, Maryland. JOURNAL OF DAIRY SCIENCE *20*, 5, p. 281, May 1937.

It was found that butterfat in milk or cream must be liquid to obtain proper homogenization.   A.C.D.

473. The Effect of Fat Content on Oxidized Flavor in Milk and Cream. CHAS. T. ROLAND AND H. A. TREBLER, Sealtest, Inc., Baltimore, Maryland. JOURNAL OF DAIRY SCIENCE *20*, 6, p. 345, June 1937.

The sensitivity of milk to develop oxidized flavor increased with increased fat content.   A.C.D.

474. Mastitis Detection and Control. RALPH B. LITTLE, The Rockefeller Institute for Medical Research, Princeton, N. J. Conven. Intern. Assoc. Milk Dealers, Production Section, p. 71, 1936.

Both acute and chronic types of mastitis can be produced experimentally in the udders of first half heifers by conveying small numbers of streptococci beyond the meatus of the teat. With the short chain streptococci the infection is acute. With the long chain varieties of nonhemolytic streptococci the disease process is much milder.

In the control of mastitis the laboratory examination of the milk is superior to any other single method. However, for the successful operation of any control measure the dairyman should have the full cooperation of his veterinarian.   E.F.G.

475. The Vitamin C Content of Cow's Milk. S. K. KON AND M. B. WATSON, Nat'l Inst. for Research in Dairying, Univ. of Reading, England. Biochem J. *31*, p. 223, 1937.

Vitamin C may be present in two forms, as ascorbic acid and as dehydroascorbic acid. Both are biologically active, but the latter does not react with indophenol reagent unless treated with H_2S, is labile and undergoes spontaneous decomposition associated with loss of biological activity. Under the action of light the reduced form of ascorbic acid present in milk is reversibly oxidized to dehydroascorbic acid. This paper deals with the state in which vitamin C is secreted by the cow and presents estimations of the vitamin C content of herd milk at different times of the year under south England conditions.

The healthy mammary gland of the cow secretes milk, the vitamin C of which is only in the reduced form of ascorbic acid. No reversibly oxidized ascorbic acid is found in milk as it leaves the udder. The season of the year and the nutrition of the cows have no effect on the vitamin C content of herd milk. The average figures for herd milk (passed over a surface cooler) from 26 Shorthorn and 3 Guernsey cows is 2.01 mg. of reduced and 2.37 mg. of total ascorbic acid per 100 ml. during a stall feeding period, and 2.06 and 2.35 mg./100 ml., respectively, on early pasture feeding. The vitamin C content of colostrum is only slightly greater than that of milk.   K.G.W.

476. The Source of Vitamin D in Summer Milk. JOHN EDWARD CAMPION, KATHLEEN MARY HENRY, S. K. KON, AND JAMES MACKINTOSH, Nat'l Inst. for Research in Dairying, Univ. of Reading, England. Biochem. J. *31*, p. 81, 1937.

Eight Shorthorn cows were divided into four groups of two each and placed on the following treatments: Group 1 kept indoors on winter ration which included 5 lb. of hay daily per cow; Group 2 kept outdoors exposed to sun and sky-shine, given same ration as Group 1; Group 3 out on pasture; Group 4 kept indoors but given 1 cwt. daily per cow of freshly cut grass, and the same summer maintenance and production ration as given Group 3. The experiment lasted from May 1 to June 30, 1936. The vitamin D in the fat was determined by prophylactic bone ash tests. The butterfat from cows outdoors and indoors on the summer ration had potencies of 0.46 and 0.15 I.U. per gram, respectively (ratio of potencies 3:1), while the figures for similar butters produced on the winter ration were 0.88 and 0.27 I.U. per gram, respectively (ratio of potencies 3:1). The average total amount of vitamin D secreted daily by a cow was as follows: Group 1, 110 I.U.; Group 2, 313 I.U.; Group 3, 252 I.U.; Group 4, 52 I.U. The yields per kg. of milk were 8.3, 26.0, 17.0 and 5.3, respectively. The cows (whether fed outdoors or indoors) on the winter ration which contained hay secreted more vitamin D than the corresponding cows on summer feed consuming a plentiful supply of fresh grass. It is concluded from the experiments that the direct exposure of the cow to sun and sky-shine contribute all, and the pasture none, of the increase in the vitamin D potency of milk which takes place in summer.   K.G.W.

477. A Comparison of the Vitamin D Contents of Guernsey and Shorthorn Butter (Milk). STANISLAW K. KON AND KATHLEEN M. HENRY, Nat'l Inst. for Research in Dairying, Univ. of Reading, England. Biochem. J. *30*, p. 776, 1936.

The vitamin D contents of Guernsey and Shorthorn butter fats produced on pasture under similar conditions of feeding and management were compared. · The Guernsey butterfat was found to contain 0.35, the Shorthorn

0.28 I.U. of vitamin D per gram, as determined by protective technique and bone ash calcification.   The difference is not statistically significant.

K.G.W.

Other Abstracts of interest are numbers 436, 437, 438, 439, 440, 441, 442, 444, 451, 452, 453, 454, 455, 457, 458, 459, 460, and 461.

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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JOURNALS

American Creamery and Poultry Produce Review
American Journal of Diseases of Children
American Journal of Public Health
Archives of Pediatrics

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Certified Milk

Dairy Produce Review
Dairy World
Deutsche Molkerei Zeitung

Food Industries
Food Manufacture
Food Research

Ice and Refrigeration
Ice Cream Field
Ice Cream Industry
Ice Cream Review
Ice Cream Trade Journal
Industrial and Engineering Chemistry

Journal of Agricultural Research
Journal of American Chemical Society
Journal of American Medical Association
Journal of Bacteriology
Journal of Biological Chemistry
Journal of Dairy Research

Journal of Dairy Science
Journal of Experimental Medicine
Journal of General Physiology
Journal of Infectious Diseases
Journal of London Chemical Society
Journal of Nutrition
Journal of Pathology and Bacteriology
Journal of Physical Chemistry

Kaeseindustrie
Kolloid-Zeitschrift

Lancet
Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry

Milk Plant Monthly
Molkerei Zeitung

National Butter and Cheese Journal

Pacific Dairy Review

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zentralblatt für Bacteriologie

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers
International Association of Milk Inspectors

National Dairy Experiment Station, Hillerod, Denmark
National Institute for Research in Dairying, Reading, England

New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BACTERIOLOGY

478. Studies with A "Different Method" of Appraising Standard Plate Counts. C. SIDNEY LEETE, 24th Annual Report of Intern. Assoc. Dairy and Milk Inspectors, p. 28, Oct., 1935.

The method described in this paper is known as the "three out of four" method; it is compared to the arithmetic average and logarithmic average methods for appraising the value of a series of standard plate counts when used in determining grades of milk, degrading and in revoking milk permits.

The method consists of taking a series of four consecutive counts; if three of the four counts are within the grade, the supply is considered officially satisfactory.

The study was made on 1912 standard plate counts, and examples are cited showing the "three out of four" method to give a truer picture of the actual quality of the milk supply than either the arithmetic or logarithmic averages.

The "three out of four" method is adaptable for milk control administration.   L.H.B.

479. Sources of Infection in Septic Sore Throat Epidemics. GEORGE H. RAMSEY, 24th Annual Report Intern. Assoc. Dairy and Milk Inspectors, p. 163, Oct., 1935.

Since July 1925, there were seventeen epidemics of septic sore throat reported in New York State. Each was attributed to a raw milk supply. Detailed investigation was made of thirteen of these at the time of the outbreak or shortly after. Each investigation included special epidemiological and bacteriological studies, and the careful investigation.

In seven of the thirteen epidemics, it was found that prior to the outbreaks one or more persons on the farms were involved. In four instances, there were cases of sore throat and in the other three, there were cases of hand infection in the dairy workers.

There were only two of outbreaks in which no human illness could be found on the farms inspected. In all of the eleven other cases the presence of illness on the farm at some time or other was definitely established.

In ten of the epidemics, hemolytic streps more or less similar to those from the humans involved were isolated from a single cow in each case. In the other three cases, streptococci were isolated from cows which were not similar to those from the septic sore throat patients.

In each of these instances the cows involved were animals with a history of a teat injury or mastitis.

If milk must be sold raw then every person on a dairy farm who has a sore throat, suppurating lesions, or any illness which might be due to a streptococci infection must be prohibited from handling milk, and milk from all cows with severe mastitis or teat injuries must not be used.

L.H.B.

BUTTER

Abstracts of interest are numbers 480, 481, 492, 499, and 500.

CHEMISTRY

480. Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists. 4th Edition, 1935, pp. 710. Published by the Association of Official Agricultural Chemists, Washington, D. C. Price $5.00.

The fourth Edition of Methods of Analysis follows the plan of revising the methods every five years.

New methods for the analysis of dairy products included for the first time in this edition are given for the determination of citric acid and sediment in milk; and of lactose and gums in cheese. This volume has been increased in size by 117 pages.

The A. O. A. C. methods have proved so useful to analytical chemists and have gained such widespread adoption in dairy laboratories everywhere that a review need only announce the new edition. A.C.D.

481. The Chemistry of Milk. W. L. DAVIES, pp. 522, 1936. Published by Chapman and Hall, Ltd., 11 Henrietta St., W.C. 2, 1936.

This book is the tenth in a series on applied chemistry published under the Editorship of E. Howard Tripp. In the preface he states that the book was written for "experts in related fields of science" and for the "well-educated layman" to "focus attention upon recent work" or to consider new aspects of old work.

Dr. Davies wrote the book to apply to pure and applied chemists and others with the thought of covering the field rather thoroughly. He states in the preface that several other books were used in "planning the various sections." A glance at the contents of the book indicates that the organization of material is somewhat similar to Fundamentals of Dairy Science.

The five sections in which the book is divided are, 1, the composition of milk, 2, the constituents of milk, 3, the physical chemistry of milk, 4, the chemistry of milk processing, and 5 the nutritive value of milk. The literature citations and discussion of the various subjects are sufficiently complete and clear to give a good up-to-date knowledge of the subject. Although the discussions are chemical in nature the language and terms are such as to be readily understandable by one in related fields of science. The

author has extensively referred to writings of English and European writers which is an added value to the book for American readers. Some idea of the extensiveness of the book may be secured from the fact that about 1400 publications are cited in the references. This book is a splendid contribution in its field.   A.C.D.

CHEESE

Abstracts of interest are numbers 480, 481, and 492.

CONCENTRATED AND DRY MILKS

Abstracts of interest are numbers 478, 480, 481, 482, 491, 492, 496, 498, 499, and 500.

FOOD VALUE

482. Milk and Nutrition. Part 1. The Effect of Commercial Pasteurization on the Nutritive Value of Milk, as Determined by Laboratory Experiment. The Milk Nutrition Committee from the National Institute for Research in Dairying, Shinfield, Reading, England, and The Rowett Research Institute, Bucksburn, Aberdeen, Scotland. 1937, price 3 shillings post paid.

This publication is based upon an extensive study of the influence of commercial pasteurization of milk upon its nutritive properties. The data secured thus far deal with feeding experiments with rats and chemical analysis of the milk. The plan of the experiment was such that the raw and pasteurized milks were secured from the same original batch and the milks were processed commercially. Many variants which affected numerous previous investigations were carefully controlled.

The milk was heated in a plate heater to 142 to 150° at which temperature it was held for 28 to 44 minutes. The phosphatase test was negative. The pasteurized milk varied in bacterial count from 460 to 44,000. The milk contained 3.9 per cent fat and 12.7 per cent total solids.

Raw and Commercially Pasteurized Milks as Sources of Calcium and Phosphorus for the Growing Rat.

K. M. HENRY AND S. K. KON.

The experimental rats were litter mates fed a ration containing 60 to 70 per cent of thin calcium and phosphorus requirements. About 80 per cent of these minerals were secured from milk. It was found that the rats assimilated about 80 per cent of the calcium and phosphorus intake irrespective of the kind of milk fed. From the viewpoint of these two important minerals the food value of raw and pasteurized milk were equal for rats.

An Investigation into the Effect of Pasteurization on the Availability of Calcium and Phosphorus of Cow's Milk.

D. W. AUCHINACHIE.

This investigation was a duplicate of the previous one but was carried on at another Experiment Station.   The author concluded that "the retention of calcium and phosphorus of milk determined by balance experiments on growing rats have been found to be unaffected by pasteurization."

The Effect of Commercial Pasteurization on the Biological Value and Digestibility of the Proteins of Milk.

K. M. HENRY, S. K. KON, AND M. B. WATSON.

From rat feeding experiments using the method of Mitchell it was found that the protein of raw milk was 95.06 per cent digestible as compared with 95.65 per cent for pasteurized milk.   Relatively low biological values of 80.73 for raw and 81.45 for pasteurized milk proteins were secured due to milk being the sole diet.   It was concluded that pasteurization had no effect upon the digestibility of the milk proteins.

The Effect of Commercial Pasteurization on the Vitamin A and Carotene Content of Milk.

A. E. GILLAN, K. M. HENRY, AND S. K. KON.

In these experiments the vitamin A and carotene content of the butterfat were determined by the Lovibond Tintometer and the spectrophotometer. Data on 20 samples of butterfat showed that no vitamin A or carotene was destroyed by pasteurization.

The Effect of Commercial Pasteurization on the Vitamin B Complex of Milk

S. K. KON.

The rats in this feeding experiment were fed a vitamin B complex free diet until they began to show the effects of this deficiency in the diet.   Then 8 ml. of milk were fed daily, an amount ample to promote growth at a subnormal rate.   It was found that the female rats grew equally well on raw or pasteurized milks but the male rats receiving raw milk made greater gains than the male rats receiving pasteurized milk.   The author concluded that pasteurization did destroy some of the vitamin B complex but the extent of the loss was not known.

*The Effect of Commercial Pasteurization on the
Vitamin C of Milk.*

S. K. KON AND M. B. WATSON.

The vitamin C content of the milk was determined by chemical titration. From data secured over a period of 4 months the vitamin C content of raw milk was 22.2 mg. per liter as against 17.5 mg. per liter for pasteurized milk. Pasteurization destroyed 20.8 per cent of the vitamin C in milk.

*Comparison of the Total Nutritive Value of Raw and Commercially
Pasteurized Milks.*

K. M. HENRY AND S. K. KON.

Milk, fortified with iron, copper, and manganese, was the sole diet of the rats in this experiment. The male rats used in the trial were liberally fed but the rats receiving raw milk were fed exactly the same volume as those given pasteurized milk. When judged by any or all standards employed, namely gain in weight, body length, composition of carcass, and appetite there was no difference between the nutritive value of raw and pasteurized milk. A.C.D.

ICE CREAM

483. An Antioxidant for Ice Cream. C. D. DAHLE AND D. V. JOSEPHSON, Penn. State College. Ice Cream Field *31*, 1, p. 15, May, 1937.

The authors claim that the most common flavor defect in foods containing fat is the one arising from an oxidation of fat. The defect is more likely to occur in ice cream during the winter months, primarily because the average storage period is longer in winter than summer.

As a means of preventing oxidized flavors antioxidants are often used in food products. Finely ground oat flour known as avenex No. 7 was used as the antioxidant in this study. To facilitate the development of the oxidized flavor in ice cream 2 p.p.m. of copper was added to the mix and in some instances the mixes were not homogenized. In addition the comparisons were made largely with strawberry ice cream since it is more susceptible to the development of oxidized flavors than plain. The composition of all mixes was 13 per cent fat, 10.5 per cent serum solids, 15.5 per cent sugar and 0.35 per cent gelatin. Fresh cream was used as the source of fat in most cases but in some of the comparisons frozen cream was employed. The samples were stored at -10 to $-20°$ F.

It was found that 0.5 per cent to 0.7 per cent added oat flour delayed the onset of oxidized flavor for several weeks in most cases.

When added to fresh cream before being frozen for storage a definite protection was afforded the ice cream made from the cream. The body score of the ice cream was increased by the addition of 0.5 per cent to 0.7 per

cent of the oat flour. The authors recommend 0.5 per cent oat flour rather than a greater amount because of the effect on the viscosity of the mix. W.C.C.

484. Reports Fountain Sales in Chain Drug Stores. (ANONYMOUS.) Ice Cream Trade J. *33*, 6, p. 16, June, 1937.

According to the U. S. Bureau of Foreign and Domestic Commerce, fountain sales in chain drug stores were 9.37 per cent greater in March, 1937, than they were for March, 1936. Total net sales were 8.5 per cent greater for the same period. W.H.M.

485. Essential Factors Involved in Making High Quality Ices and Sherbets. S. L. TUCKEY, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *33*, 6, p. 17, June, 1937.

The kind and amount of sugar and stabilizer to use in the manufacture of sherbets and water ices are given. Recommendations are also made regarding overrun in these products. W.H.M.

486. Bureau Classifies Plants in Production Groups. (ANONYMOUS.) Ice Cream Trade J. *33*, 6, p. 18, June, 1937.

According to the U. S. Bureau of Foreign and Domestic Commerce 1935 census of manufacturing plants, 31 per cent of the plants manufacture 81 per cent of the ice cream gallonage. Sixty-nine per cent of the plants make less than 50,000 gallons each and 19 per cent of the total gallonage. W.H.M.

487. Report of Committee on Laboratory Methods. A. H. ROBERTSON, 24th Annual Report of Intern. Assoc. Dairy and Milk Inspectors, p. 77, Oct., 1935.

This report tabulates replies from 72 laboratories to a questionnaire sent out regarding bacterial standards and methods of analysis used to determine the bacterial content of frozen desserts.

Its intent was to ascertain to what extent the present "Standard Methods" of the A. P. H. A. were being used. L.H.B.

488. When Ice Cream Means Votes. FRED E. KUNKEL. Ice Cream Trade J. *36*, 6, p. 23, June, 1937.

A Washington, D. C., ice cream plant along with other merchants has used successfully what is known as an Ada Christy campaign to stimulate sales and get new business. During a ten week period $2,000 in cash awards is made to the various women's organizations which take part in the campaign. W.H.M.

489. Sanitation in the Ice Cream Plant. M. J. PRUCHA, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *33*, 6, p. 25, June, 1937.

Ice cream should be safe, have a low bacteria count, and be free from all extraneous matter. High counts may be due to the growth of bacteria in the mix before freezing, contamination of the mix and ice cream by unsterile equipment, and by ingredients added during freezing. The following recommendations are given for treatment of utensils and equipment:

1. Exposure to 170° F. for at least 15 minutes, or 200° F. for 5 minutes in a steam cabinet; or

2. Exposure to a jet of steam for at least one minute; or

3. Exposure to a chlorine solution containing at least 50 parts of chlorine per million for one minute; or

4. Immersion in hot water at 170° F. or higher for at least two minutes.   W.H.M.

490. Who Should Own the Sales Cars? (ANONYMOUS.) Ice Cream Trade J. *33*, 6, p. 27, June, 1937.

The advantage of company-owned and salesman-owned cars are presented. In order to decide the better method for each respective company the best method to follow is to establish a definite system of accumulation cost figures and from this determine the most practical policy. Indications are that cost per mile seems to be in favor of company-owned cars.
                                                              W.H.M.

491. Air Conditioning in Ice Cream and Dairy Plants. G. O. WENDELL, York Ice Machinery Corp., Ice Cream Trade J. *33*, 6, p. 30, June, 1937.

Air conditioning is defined and the difference between summer and winter operations are given. A summer air conditioning system cleans, cools, dehumidifies and circulates the air and also brings in a certain predetermined amount of outside air for ventilation; a winter air conditioning system cleans, heats, humidifies and circulates the air and also brings in a certain predetermined amount of outside air for ventilation; and a year-'round air conditioning system cools and dehumidifies the air in summer, heats and humidifies the air in winter, cleans and circulates the air, and continuously adds to the system the desired amount of outside air brought in for ventilation.

The trend of the times is for more accurate control of the atmospheric conditions for comfort cooling as well as in the manufacturing processes in the dairy and ice cream plant. This is being accomplished by a more direct application and use of refrigeration and air conditioning. The results are more sanitary plant conditions, higher quality of products, more efficient plant operations, and finally a finer cooperation between the employees, the management, and the public.   W.H.M.

492. Milk Products. W. C. HARVEY AND H. HILL, pp. 388. Published by H. K. Lewis and Co., 136 Gower St., London, W.C. 1, England. Price 16s.

Last year these same authors published their book on Milk Production and Control. The present book on Milk Products would have a far more descriptive title if it had been enlarged to Milk Products and Their Control.

The book has eight chapters dealing with ice cream, cream, butter and margarine, cheese, condensed milk, evaporated milk, dried milk, and subsidiary milk products and uses for milk. Each chapter gives a brief history of the product, its method of manufacture, food value, and a more detailed consideration of methods of analysis, inspection, and legal control. The book, therefore, is especially useful for Public Health officials, inspectors, and students and it is written from their viewpoint.

As in the case of Milk Products the reviewer was again impressed with those parts of the book dealing with conditions peculiar to England. The authors have expressed their opinions with frankness which is to be commended, but exception should be taken to some opinions stated as facts. For example, after the authors have recommended ice cream as an excellent food they caution against "excessive consumption of ice cream" for "In the United States of America, this practice has transformed that country into a nation of dyspeptics." Perhaps the rather poor conditions in the ice cream industry in England as described by the authors has prejudiced them against all ice cream yet does not justify the assumption that the United States is a nation of dyspeptics. The book is, nevertheless, an interesting and valuable presentation of milk products and the public health.

A.C.D.

Other abstracts of interest are numbers 478, 480, 481, 482, 492, 495, 496, 498, 499, and 500.

MILK

493. The Coordination of American Milk Control Effort. LESLIE C. FRANK, 24th Annual Report of Intern. Assoc. Dairy and Milk Inspectors, p. 9, Oct., 1936.

The need for actual standardization of grade requirements for milk and also of grade labels is discussed.

An outline of the fundamental principles of the United States Public Health Service Uniform Milk Ordinance is given.   L.H.B.

494. Educational Work as a Factor in Increasing the Extent of Pasteurization. IRA V. HISCOCK, 24th Annual Report of Intern. Assoc. Dairy and Milk Inspectors, p. 46, Oct., 1035.

The two essential factors to be considered in relation to the milk supply are (a) "that production of milk on the farm must be so conducted that the

possibility of infection will be reduced to a minimum, and (b) that subsequent pasteurization must be so scientifically applied that any infection which does occur, despite the farm production precautions, will be prevented from reaching the consumer.''

The function of the milk inspector should be that of an educator rather than a policeman. He should be well trained in milk sanitation.

Plant employees should be trained in order to aid in the improvement of the efficiency of pasteurization from a public health viewpoint.

In addition to this the major problem relates to milk consumption. The public must have a more complete understanding or (a) ''the value of an adequate supply of clean, safe milk, and (b) the necessity of proper care of the milk after delivery in the home, school or restaurant.''

A number of facts concerning pasteurization which may be used in educational work are given, including the report of the committee on Foods of the American Medical Association, entitled ''The Pasteurization of Milk.''

L.H.B.

495. Radiation and the Microorganisms of Milk. K. G. WECKEL, 24th Annual Report of Intern. Assoc. Dairy and Milk Inspectors, p. 69, Oct., 1935.

The irradiation of good quality milk had very little effect on the bacterial count, however, when the numbers of bacteria in the milk being irradiated increase, there is a decided decrease in the count after the treatment.

In nine trials of low count milk, 0–50,000, the reduction after radiation ranged from + 21.5 per cent to – 22.0 per cent, average – 0.96 per cent.

In thirteen trials on milk having a count over 1,000,000, the percentage reduction ranged from – 0.69 per cent to – 59.9 per cent, average – 28.3 per cent.

It was also found that the keeping quality of irradiated milk was improved even in milk of good quality where there was no appreciable effect of radiation on the bacteria count. By introducing cultures of *Streptococcus lactis, Escherichia coli* or *Bacillus coagulaus* into the milk, it was found that the radiation as applied to milk had no selective action on the various organisms normally found in milk. L.H.B.

496. The value of the Colon Test as a Means of Detecting Unsanitary Conditions on the Farm. M. W. YALE AND RICHARD EGLINTON, 24th Annual Report of Intern. Assoc. Dairy and Milk Inspectors, p. 116, Oct., 1935.

During the first two years brilliant green lactose bile (2 per cent) was used as the medium, but was found to be too inaccurate. The third year lactose desoxycholate agar was used, and found to be more accurate. 1 ml. and 0.1 ml. of milk were plated and the large deep red colonies counted after 24 hours incubation.

Counts of colon organisms were found to vary greatly from day to day, even when the total bacterial count on yeast extract dextrose agar remained approximately the same.

More high colon counts were obtained in June, July, August, and September than in the other months.

The authors concluded that the colon test has only slight value when used as a routine test on ordinary fresh raw milk. The fluctuations in the number of colon organisms in milk from individual producers from day to day is more chiefly due to the contamination from utensils and growth in the milk than to manurial contamination.

Colon infections of the udder was rarely found to be the cause.

L.H.B.

497. Second Annual Report of the Dairy Inspection Service. C. W. ENGLAND, Maryland Agr. Exp. Sta., Bul. 408, Jan , 1937.

This report reviews the work of the Dairy Inspection Service for the year 1936.

The Dairy Inspection Service of the University of Maryland is an agency for the administration of the Dairy Inspection Law of Maryland. This law is designed to insure fair dealings between producers and dealers and provides for the licensing of dairy plants in Maryland and of testers and weighers and samplers employed in such plants.

The report contains a list of licensed testers and weighers and samplers.

C.W.E.

498. Quality Control of Market Milk. N. E. LAZARUS, Olsen Publishing Company, Milwaukee, Wisconsin, pp. 190, 1935.

Persons not scientifically trained are especially in need of a book such as this which gives in non-technical language, practical information in regard to quality control of market milk. The author has had over 20 years of practical experience in the dairy field, much of which has been in the capacity of a consultant. Much of the information is not ordinarily included in texts written from the academic viewpoint.

The use of the direct microscopic method is stressed and recommended for the examination of process samples and pasteurized milk as well as for raw milk. Different types of microorganisms found in milk are illustrated by 40 photomicrographs which should help the beginner to identify sources of contamination. The author believes that the microscopic method has not been popularized and used generally in the dairy industry because the impression has been prevalent that the test required college trained persons. One of the objectives of the book is to provide the necessary information for the untrained person.

Some of the statements on milk as a source of vitamins and the destruc-

tion of vitamins by pasteurization are unsound. The phraseology and style of the book could be generally improved.

The author has freely expressed his opinion on many controversial points. The following statements which appear on page 3 afford an example. "We have been pulling the wool over our eyes by insisting that a milk with 10,000 colonies of bacteria per cc. was safer than a milk with 100,000. From a public health standpoint, there can be only one grade of milk. It is either safe or unsafe, and mere numbers of bacteria do not determine safety."

The book will need revision in the near future if it is to be kept up to date. M.W.Y.

Other abstracts of interest are numbers 478, 479, 480, 481, 482, 487, 490, 491, 492, 499, and 500.

MISCELLANEOUS

499. Concerted Action Will Help to Solve the Problems of Truck Owners. TED V. RODGERS, American Trucking Assn. Inc., Washington, D. C. Ice Cream Trade J. *33*, 6, p. 13, June, 1937.

Fees and taxes, size and weight regulations, and safety of motor vehicles are three problems confronting all truck owners. Many levies are allegedly collected for the development and maintenance of highways and roads. Unfortunately all these funds are not used for the purpose for which they are intended. Private and for-hire truck owners can cooperate and take action to curb this misuse of highway funds. At present there is a wide variation in state regulations for trucks. In some states a 10,000 pound pay load is permissible, and 40,000 pounds may be transported in other states. This will result in a difference in cost of hauling. Wheel load is more important than gross weight of the vehicle so far as effect on the road is concerned.

Traffic safety is important, both from the standpoint of preventing costly accidents and injury or death to individuals. Education of drivers in safe operating practices is the best solution to this problem. W.H.M.

500. What the Social Security Act Means to the Ice Cream Industry. (ANONYMOUS.) Ice Cream Trade J. *33*, 6, p. 32, June, 1937.

Regulations No. 91, Bureau of Internal Revenue, Washington, D. C., gives an explanation of the taxes paid under Title VIII of the Social Security Act. Upheld by the Supreme Court the act is now an established factor to be considered in the management of industry and commerce in this country. Forty-four states, the District of Columbia, Alaska, and Hawaii have enacted unemployment compensation laws as of May 25, 1937. W.H.M.

AUTHOR INDEX

SUBJECT INDEX OF ABSTRACTS—1937

ERRATUM

March, 1937, page 33, abstract 82, paragraph 5, should read as follows:

3. Try to find persons suffering from a contagious disease, but do not penalize them by discharging or temporarily laying them off without due compensation.